The INSTITUTION *of* PRODUCTION ENGINEERS

JOURNAL

(*September* 1943, *Vol. XXII, No.* 9, *Ed. B*)

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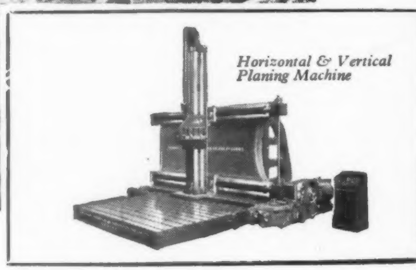

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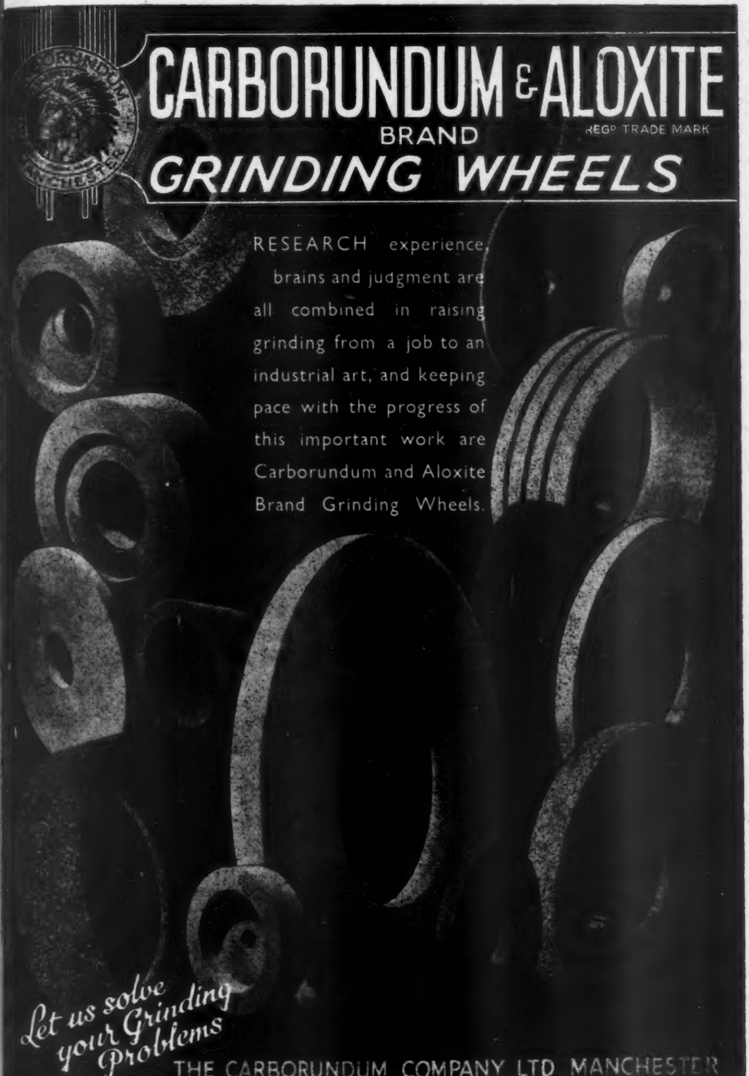

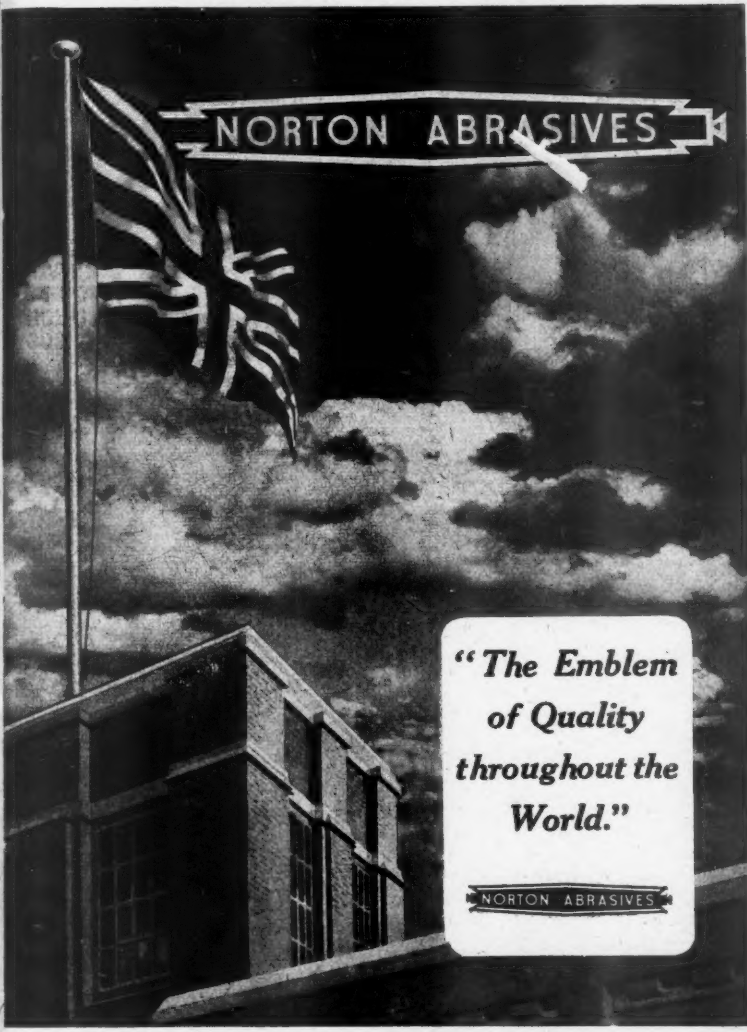
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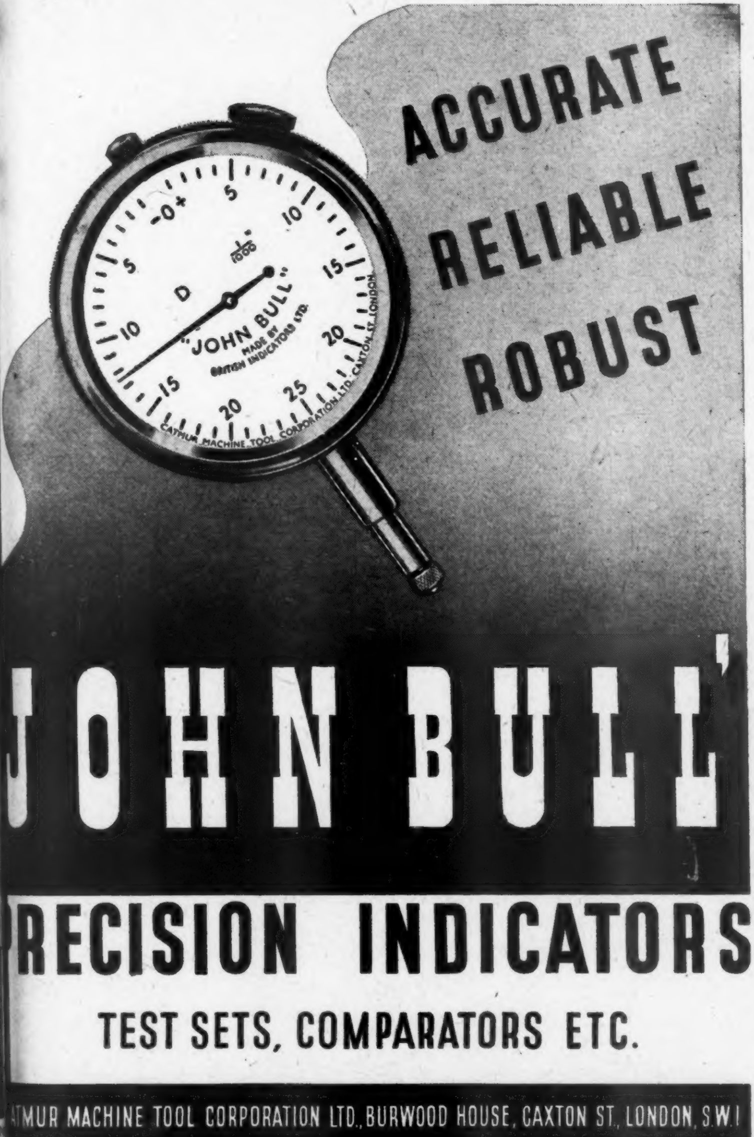
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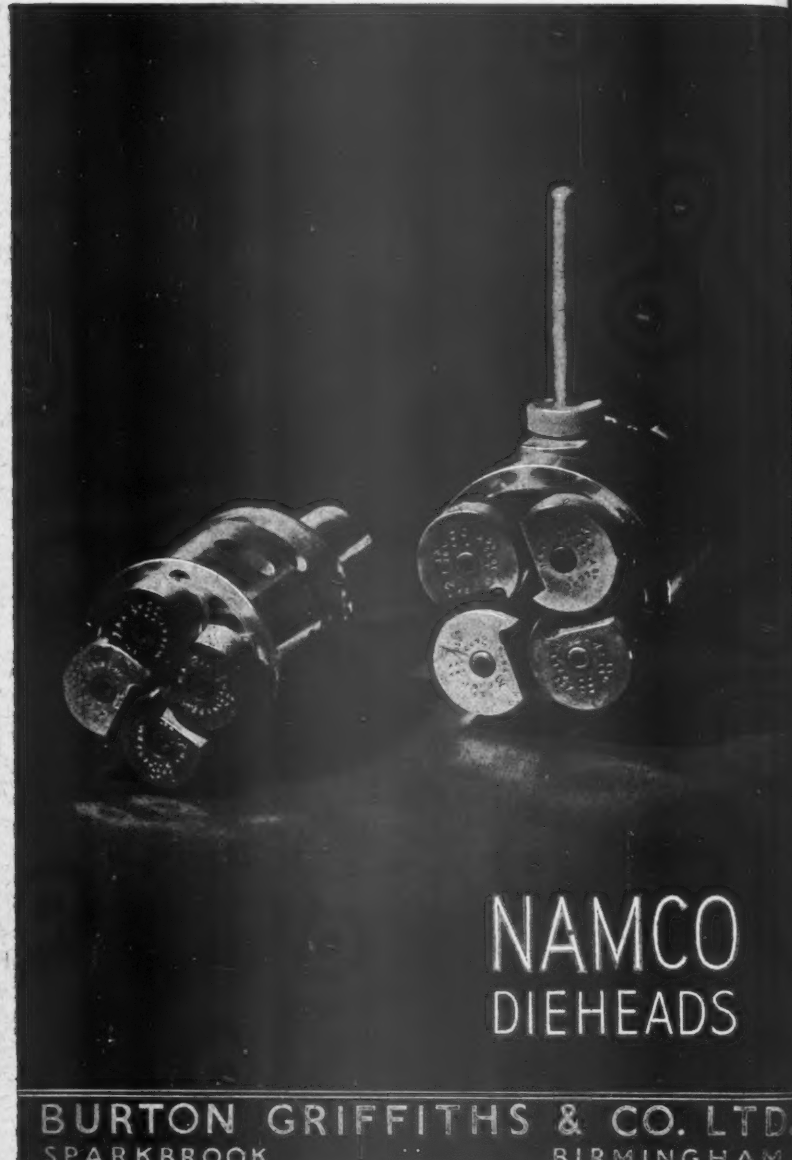
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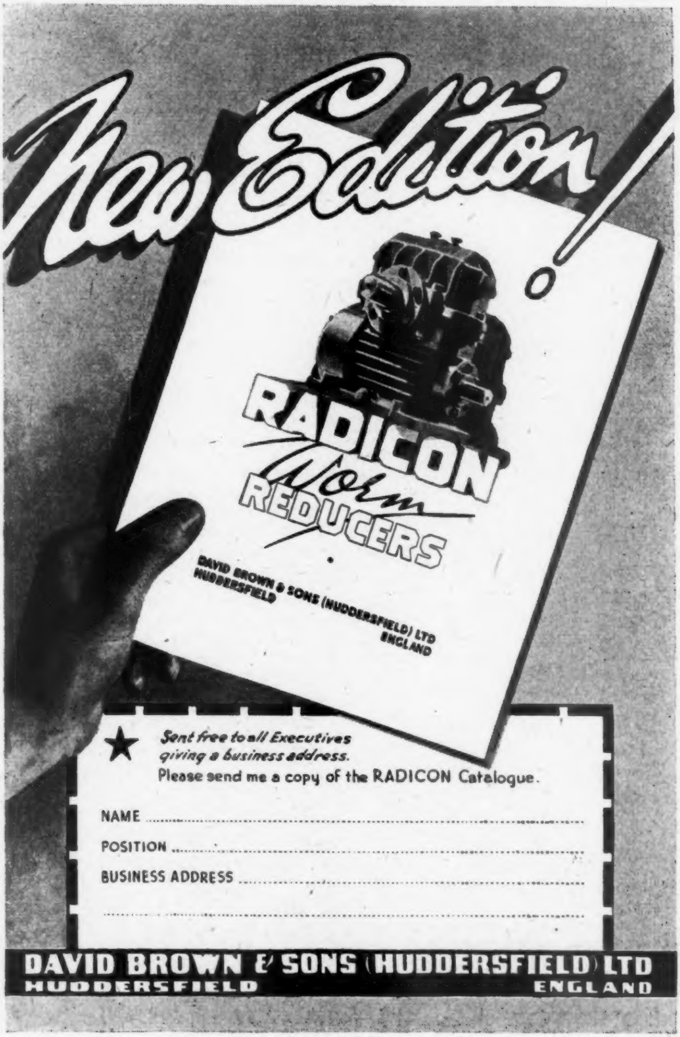
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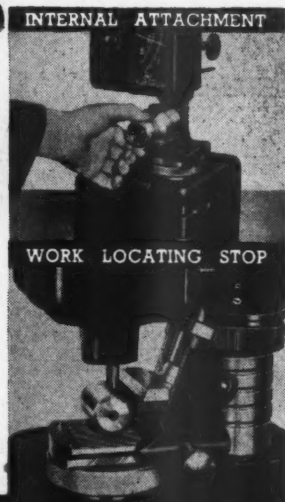

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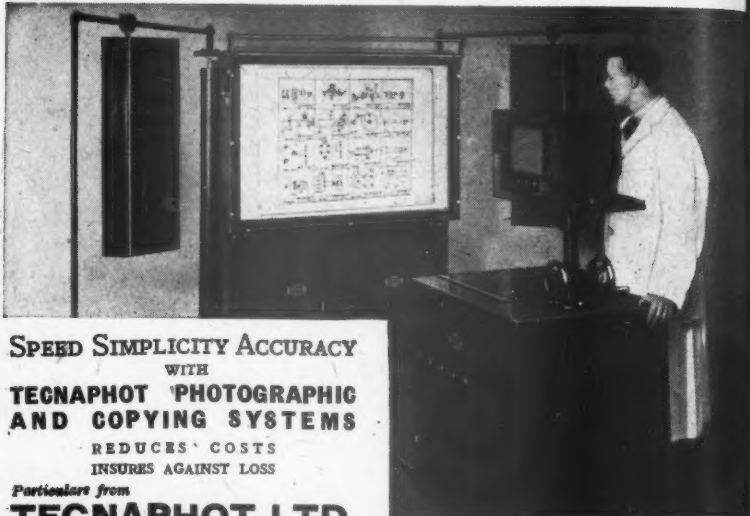

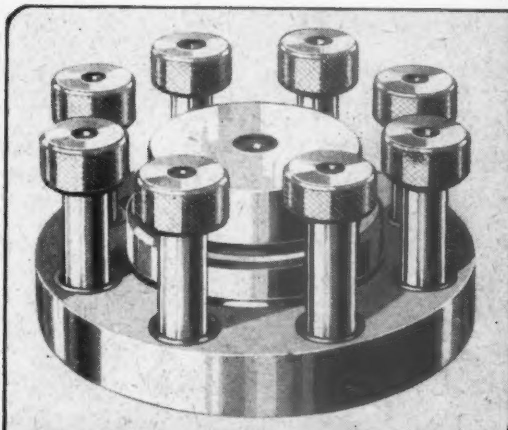


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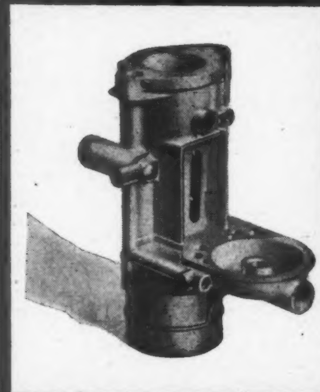

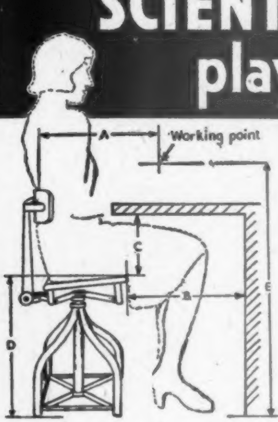

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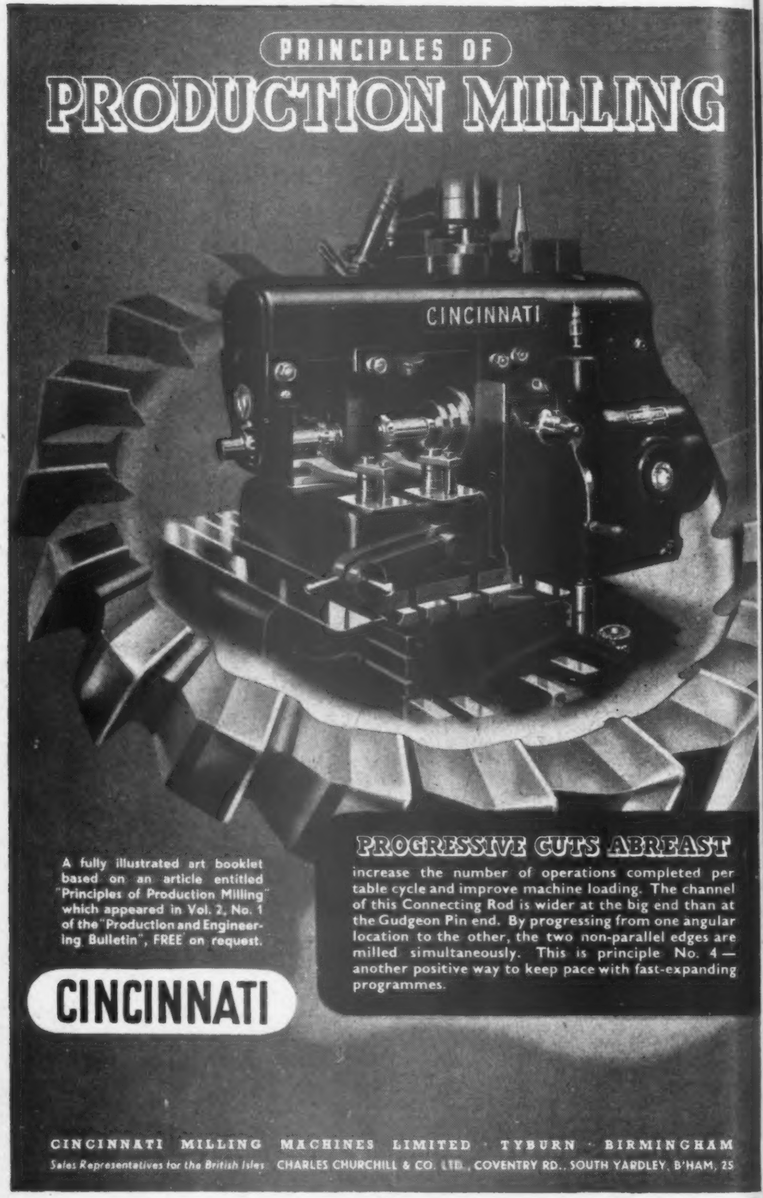
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INDEX TO ADVERTISEMENTS

As a war-time measure the advertisement section of this Journal is now published in two editions, A and B. Advertisers' announcements only appear in one edition each month, advertisements in edition A alternating with those in edition B the following month. This Index gives the page number and edition in which the advertisements appear for the current month.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in "The Journal" should not be taken as an indication that they are necessarily available for export.

The Council of the Institution

SEPTEMBER, 1943

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THE INSTITUTION OF PRODUCTION ENGINEERS

ANNUAL GENERAL MEETING

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GRADE .... SECTION ....

ADDRESS ....

Should accommodation be available for visitors, please send a ticket direct to the undermentioned non-member, who would like to be present as my guest.

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INSTITUTION NOTES

September, 1943

Annual General Meeting—October 29, 1943.

The Right-Honourable Sir Stafford Cripps, P.C., Kt., K.C., J.P., M.P., Minister of Aircraft Production, will address the Annual Meeting of the Institution to be held on Friday, October 29, 1943, at Grosvenor House, Park Lane, W.1., at 3. p.m.

Admission will be strictly limited and by ticket only, end, therefore, in view of the large demand expected, it is particularly desirous that Members intending to be present make application as early as possible. Applications for tickets should be made to the Institution Headquarters.

Annual General Meeting—Official Notice.

NOTICE IS HEREBY GIVEN that the Annual General Meeting of the Institution will be held on Friday, October 29, 1943, at Grosvenor House, Park Lane, W.1., at 3 p.m.

Agenda

1. Notice convening Meeting.
2. Minutes of previous Annual General Meeting.
3. Annual Report of the Council, Annual Report of the Research Executive and Annual Accounts for the year ended June 30, 1943.
4. Election of Auditors for 1943-44.
5. Report on Election of President and Members of Council.
6. Votes of thanks.

By Order of the Council,
K. G. Fenelon,
General Secretary and Treasurer.

36, Portman Square,
London, W.1.

Annual Elections to Council.

I HEREBY DECLARE that the following members have been elected to fill the vacancies on the Council for the year 1943/44: R. M. Buckle, F. W. Cranmer, H. J. Gibbons, R. R. Hutchings, T. Thornycroft, J. G. Young.

K. G. Fenelon,
General Secretary and Treasurer.

Extension to Research Department.

The Council, at its meeting in June last, agreed to extend the Research Laboratories at Loughborough. It is hoped to commence the building work in the next two or three weeks. These extensions will assist very considerably in enabling the Institution to carry out the proposed work as referred to in "The Research Plan"

National Certificates in Production Engineering—Pass List.

Loughborough College : A. Bowery, K. C. Brown, S. W. W. Carroll, A. B. Fitz-Herbert, F. D. Hall, W. Hewett.

Southport Technical College : K. Blair, J. D. Briggs, L. Carrington, V. Clarke, J. H. Cooper, E. Fluke, W. Jervis, H. Stott.

Fixtures.

September 24—London Section. Meeting of the Council at Institution Headquarters, 11-30 a.m.

September 24—London Graduate Section. Questions and Answers Evening. 7 p.m. 36, Portman Square.

September 26—Luton and District Section. A lecture will be given at Luton Library, Meeting Room, George Street, at 10-0 a.m. on "Forging," by Mr. R. W. Brocklehurst.

October 1—Coventry Section. A lecture will be given at The Coventry Technical College on "Engineering and its Effect on Social Life," by Dr. K. G. Fenelon.

October 2—Coventry Graduate Section. A visit to the works of Messrs. G. E. Company Ltd., Coventry.

October 4—Sheffield Section. A lecture will be given at The Royal Victoria Station Hotel, at 6-30 p.m. on "High Speed in the Wartime Production Shop," by Dr. Geo. Schlesinger.

October 8—Western Section. Invited by the Institution of Mechanical Engineers to a lecture at the Merchant Venturers Technical College, Unity Street, Bristol 1, at 2-30 p.m. on "Surface Finishes and the Function of Parts," by Dr. Geo. Schlesinger.

October 9—Yorkshire Section. A lecture will be given at the Hotel Metropole, Leeds, at 2-30 p.m. on "The Production Technique of Industrial Plastic Mouldings," by Mr. T. H. Richardson.

November 1—Coventry Graduate Section. A paper will be presentedat the Coventry Technical College (Room A5), at 6-45 p.m. on "Car Planning Principles Applied to Air Frame Production," by Mr. B. G. L. Jackman, Grad.I.P.E.

November 13—Yorkshire Section. A lecture on "Output and Environment," by Dr. K. G. Fenelon.

Newly Elected Members.

As Members : C. S. McLay.

As Associate Members : J. J. Cosford, A. G. Dalgleish, R. H. Davis, S. Francis, E. E. Keeley, K. W. Lenton, F. J. Taylor, P. H. Turnhill, G. Varey.

As Intermediate Associate Members : A. P. Akers, E. J. Bassett, K. Brierley, G. T. Brown, H. H. C. Brown, R. R. V. V. Constable, C. F. Cunningham, J. S. Dinwoodie, N. L. Eaton, H. J. Farn, W. H. Hunt, J. Jones, J. W. Lee, R. Leather, W. A. Mackrow, J. A. MacLeod, T. B. Roe, F. C. Rooke, A. M. Stelfox, W. A. Temple, C. V. Williams, T. C. Wright.

As Affiliated Firm : Millars Machinery Co., (Affiliated Representative : L. K. Leech).

As Graduates : H. Ellinger, A. Latham, R. Lancaster, V. F. Meeson, H. S. Third, H. D. Tyler.

As Students : R. S. Ashford, R. J. Birkinshaw, A. R. Bishop, W. H. Bone, A. L. Brace, L. E. B. Corr, E. G. Cowlard, L. A. Dee, R. J. Ford, P. Griggs, S. Hey, G. A. Horlsey, P. J. M. Keay, D. R. Keeler, J. W. Kelson, P. J. Lawrence, C. F. Lucas, C. J. Reed, R. V. Rider, J. C. Rookman, A. J. H. Sparkes, F. C. Tayerner, A. J. Vine.

Transfers.

From Associate Member to Full Member : J. A. Ellison.

From Graduate to Intermediate Associate Member : L. W. Wood.

From Student to Graduate : L. Rhowbotham.

Obituary.

We deeply regret to learn of the death of the following Members of the Institution :—

E. D. Unwin, Grad.I.P.E., R. F. Blake, A.M.I.P.E., N. Robinson, A.M.I.P.E., I. K. Thom, M.I.P.E.

From information received we understand that Mr. Unwin was killed in Burma soon after the Japanese entry into the war and that Mr. Thom lost his life in a flying accident in Eire in July.

NEW GENERAL SECRETARY

Dr. Kevin G. Fenelon has been appointed General Secretary of the Institution. He was educated at Merchiston Castle School, Edinburgh, then at Edinburgh University, where he graduated as Master of Arts (with first class honours in economic science) and Doctor of Philosophy, also winning prizes in history, political economy and political science.

In 1921 he was appointed lecturer in economics at Edinburgh University, and at the same time served on the University Extramural Committee and on the Joint Advisory Committee on Adult Education in S.E. Scotland. He was also vice-president of the Workers' Educational Association and subsequently president and chairman of the executive council.

Dr. Fenelon moved to Manchester in 1931, when he was appointed Director of the Department of Industrial Administration at Manchester College of Technology. He also became Head of the Department of Industrial Administration at the University of Manchester, supervising research students working for master's and doctor's degrees post graduate certificate course, and courses in management for undergraduate students from mechanical, electrical, municipal, and chemical engineering, and other departments. His wartime work there has included the supervision of intensive courses for foremen, women supervisors in engineering, quality control by statistical methods, and cost office routine.

In addition to being an active member of many leading scientific societies, he has contributed frequently to varied technical journals on management, labour, industrial and economic subjects. His research work has included "Labour Management in Wartime," "Rehabilitation and Resettlement," "Colour in the Factory," and "Blind Workers in Industry." Published works include "The Economics of Road Transport," "Transport of Co-ordination," "Railway Economics," "Management and Labour," and "British Railways."

KEVIN G. FENELON, M.A., Ph.D.

RADIAL AERO ENGINE PRODUCTION IN AUSTRALIA

Paper presented to the Institution, Sydney, N.S.W. Section, on July 14, 1942, by J. Piggott, A.M.I.P.E.

It is rather difficult to know just where to commence, and just what to leave out of a paper dealing with so wide a subject as Aero Engine Production.

It is proposed to briefly run through some photographs of components and sub-assemblies of a large radial aero engine, to follow this up with an outline of the various problems affecting manufacture, and to conclude with some selected examples of production set-up and tooling.

Photographs of Components and Sub-Assemblies.

The following photographs show the principle components of this engine.

Fig. 1. Cylinder and barrel assembly.

Fig. 2. Nose section—front, centre and rear crankcases—Blower—inter rear and rear. These components utilize 650 ground thread studs.

Fig. 3. Complete gear train.

It might also be of interest to quote the power weight ratio which equals 1.23 lb. per h.p.

An Outline of Problems Affecting Manufacture.

From a production engineer's point of view, the following problems arise :—

(1) The very large number of differing component parts.

(2) The large variety of special materials to strict specification requirements.

(3) The close tolerances specified for small to large size component parts.

(4) Inspection requirements.

With regard to (1): The large number of differing component parts. Firstly this entails designing and manufacturing more tools and gauges, and secondly it almost prohibits " line production " except in cases where the number of components per engine is relatively high and therefore justifies such plant.

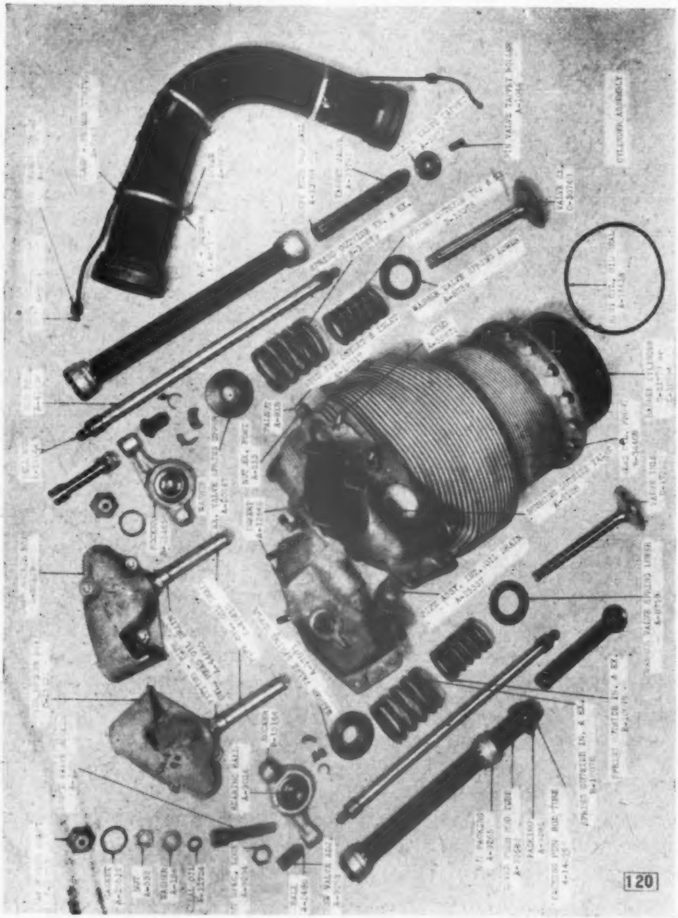

Fig. 1.

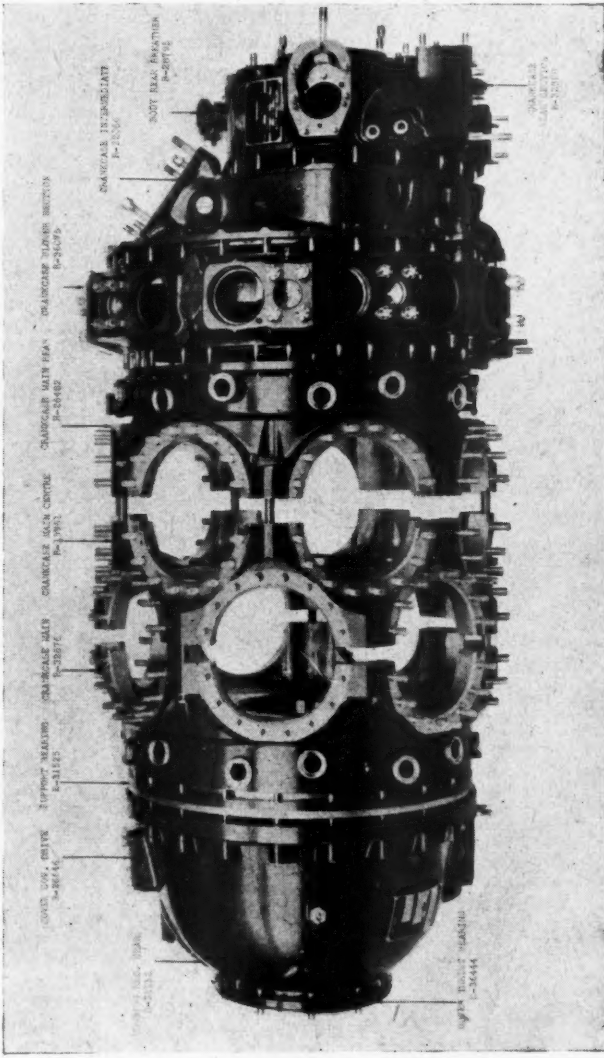

Fig. 2.

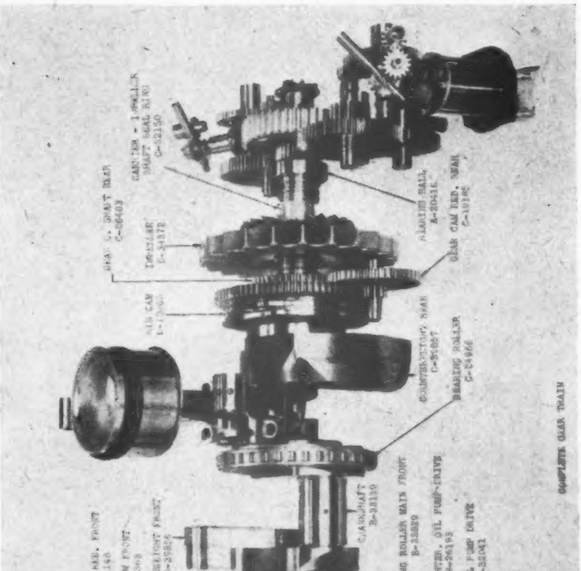

Fig. 3.

Line production can only be applied to a relatively small number of components, and the majority of parts must necessarily be produced in comparatively small batches, necessitating frequent setting up.

This method naturally creates problems, not the least of which is the difficulty of obtaining sufficient skilled men who know how to go about the job of setting up from the ground up, eliminating one by one the possibilities of trouble later on.

As far as possible, the jigs, fixtures and tools are designed with these set-up problems in mind. Small batches require much more careful planning, in order to keep parts flowing, and here again set-up troubles, which are sometimes mis-called tooling troubles, frequently upset the best laid plans of those responsible for setting down just how much shall be produced in a certain time.

With regard to (2): The large variety of special materials to strict specification requirements.

This is a problem for both the metallurgical and supply departments, particularly when pioneering new sources of supply.

With regard to (3): The close tolerances specified for small to large size component parts.

This presents further difficulties, in that the bulk of production is carried out by semi-skilled labour.

With line production set-ups, this problem is usually disposed of before production commences.

With continual " breaking down " and " setting up," sizing for close tolerance work becomes a problem, and affects both the scrap and the salvage percentage.

As far as possible, fixtures are designed to incorporate " built in " gauging facilities, in an endeavour to reduce scrap and salvage.

Where these gauging facilities are provided, the inspector can quickly check the part before it is removed from the fixture in the machine, thus facilitating the correction of the component should this be necessary.

In some cases, particularly early operations on castings and forgings, it is almost impossible to re-locate the part in the fixture.

Close tolerances for component parts also mean closer tolerances for tools, fixtures and gauges, as all important sizes on these are carefully dimensioned using a system of tolerances in order to facilitate toolroom output, and therefore any decrease in tolerances adversely affects both the scrap and man hour figures in the toolroom.

With regard to (4): Inspection requirements.

Inspection is divided into five distinct groups, as follows :—

(*a*) *Metallurgical Inspection.* Where all raw materials are tested and where the heat treatment of components is checked and

controlled, also the hardness of all finished steel parts being determined prior to assembly.

(*b*) *Gauge Room Inspection.* This department controls the standards of accuracy for the whole plant. All newly manufactured tools, jigs and gauges are carefully inspected here, as well as the periodical checking of all gauges for wear. Difficult "first-off" components from production are also checked by the gauge room, who actually are the consultants for the technique of inspection methods.

(*c*) *Works Inspection.* The inspection of component parts at each operation and finally at the finished stage.

An important requirement is the "first-off" inspection, whereby the first components produced after a new set-up must be approved by works inspection before manufacture can be proceeded with.

All magnetisable materials are subjected to the important magnaflux test in order to detect the presence of small cracks, seams, non-metallic inclusions, and other defects on and immediately below the surface.

This process consists of magnetising the part to be inspected and immersing it in a bath of kerosene in which a very fine magnetic iron oxide powder is kept in suspension by constant agitation of the bath.

The two edges of any crack on or near the surface which extend at approximately right angles to the magnetic flux of the magnetised part will assume North and South polarity, and when the part is immersed for a few minutes in the bath, the iron oxide particles will bridge the gap between the poles.

Indications are strongest when the defects are at 90° to the flux, and gradually decrease in strength as the angle approaches zero.

Therefore, two magnetisations at right angles to each other should show up all defects.

It is important to test the following :—

(1) Highly stressed and complex parts which contribute basically to the reliability of the engine.

(2) All case hardened parts which have ground grooves or flanges where grinding with the side of the wheel is required.

This latter can be readily understood when one considers how easily wheels "glaze up" when side grinding, and thus cause "checking" or fine cracking of surface.

In addition to metallurgical and dimensional requirements, surface finish is now being specified, more however as a means of helping the manufacturer to meet the quality engineer's ideas, rather than a strict and rigid inspection requirement.

The finishes specified vary from 3 to 15 micro inches, root mean square average of imperfections.

This is apparently in accordance with the proposed American Standards on Surface Finish, as described by Dr. Schlesinger in the *Journal*.

The root mean square average is obtained as follows :—

> Ordinates above and below a base line are measured, squared, added, divided by the number of ordinates, and then the square root taken.

This is supposed to give a better average than the proposed British Standard, the Arithmetical Mean, although according to Dr. Schlesinger, the difference between the two methods are generally small enough to be neglected.

It is proposed to use a Profilometer employing a tracer point having a very minute radius, and which is traversed by hand across the surface to be tested at right angles to the machining marks, the reading being noted upon a dial.

It is worth noting that the specifications state that the specified finishes are not intended to control the *method* of finishing.

(*d*) *Assembly Inspection* consists of a general inspection during and after assembly, and also during the testing of the engine during the green and final run.

Before green assembly, all important clearances are checked and parts visually examined.

The engine is then given its green test run, consisting of 10 to 12 hours at varying speeds and conditions.

After tear down or dis-assembly, visual examination is carried out, certain dimensional checks made, and all magnetisable materials magnafluxed.

The engine is again assembled and then subjected to the final or acceptance test run of approximately three hours.

Finally.

(*e*) *A.I.D. Inspection.* This department has the final say in what shall be accepted, more particularly with "salvaged" parts, for which "concessions" have to be obtained.

The remainder of this paper is devoted to :—

EXAMPLES OF PRODUCTION SET-UPS, TOOLS AND GAUGES

Grinding Liners in Crankcases.

The assembled crankcase is mounted in a large internal grinding machine.

The operation consists of grinding the bores of thin, hardened steel liners, which have been shrunk into the bores of the various units of the crankcase assembly.

This example is interesting because of the size of the component part, which measures approximately 21 in. diameter by 19 in. long.

The bores of the liners being ground are approximately 6 in. diameter, with a grinding tolerance of $\pm$ .0005.

The grinding wheel, which is 4 in. diameter by $1^1/_2$ in. long, is a 3860KBE, and wet grinding is employed.

The faceplate of the machine is 36 in. in diameter, and has been designed to locate other types of fixtures, some of which are considerably out of balance. To correct this, facilities in the shape of slotted plates are provided, in order to enable counter-weights to be bolted to the faceplate in the appropriate positions.

Finning Cylinder Barrels.

Cylinder barrels are finned on a machine employing three banks of finning tools which are operated by cams.

There are 21 fins in the barrel, spaced $^9/_{64}$ in. apart, $^1/_2$ in. deep and slightly tapered.

The material is an alloy steel of 70 tons tensile.

The barrel is located upon air operated expanding arbor, and supported at the other end by a heavy tailstock centre.

In operation, the front box, which comprises the roughing or gashing bank of tools, commences cutting, whilst the top and rear boxes follow approximately .010 in. behind the gashing tools.

In addition to the inward feed, the top and rear boxes, which each finish one side of the bank of fins, are also given an axial movement by means of another cam. This produces the slight taper on the fins.

The work speed is 33 ft. per min., the tools feed in at .003 in. per revolution of work, and a copious supply of cutting oil is used.

The finning tools are composed of a special high speed steel, an 18-4-1 with .9 to 1% carbon, instead of the usual .7%.

Tool life is approximately 30 barrels between grinds. Complete boxes of tools are changed, and setting gauges used to set the spare tools in the spare boxes, so that the change over is affected in the shortest possible time, without re-sizing.

Spline Milling Propeller Shafts.

The propeller shaft, which has 16 straight sided splines, is spline milled to a tolerance of .001 in. on width of splines.

The component is located between centres in a large indexing fixture, which is mounted on the table of a horizontal milling machine.

The indexing plate attached to the headstock is jig bored and bushed to suit the number of splines, and a hardened and ground plunger locates each hole.

Owing to the relatively large diameter of the indexing plate, a high degree of accuracy is obtained in the spacing.

Special means are adopted to centralise the cutter, which has ground relief.

Diamond Boring Pistons.

The otherwise finned piston is set up to bore the piston pin holes to finished size. This operation is carried out on a Borematic boring machine, two spindles boring both sides simultaneously to a

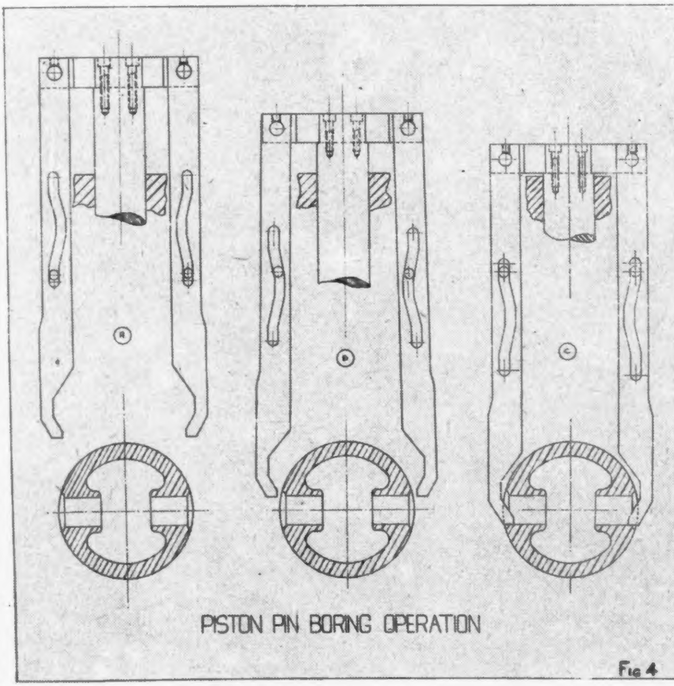

Fig. 4.

tolerance of .0005 in., and .012 in. is removed on diameter, or .006 in. depth of cut.

For best results with the diamond tools, only a small amount per cut may be removed, and consequently the setting up of the

piston is of major importance, otherwise the percentage of scrap at this operation may be high owing to one side of the piston pin hole not cleaning up.

The piston is firstly located by means of a spigot in a specially machined locating diameter inside the skirt.

The second and more difficult location is that of twisting the piston until each end of the piston pin holes is equally lined up with the machine spindles.

This is done by means of two fingers operated from the rear of the fixture. (Fig. 4.)

At A the locating fingers are well back, and clear of the boring bars.

At B the fingers are being brought forward, and by means of a cam track and pin, clear the sides of the piston pin hole.

At C the fingers are in the locating position.

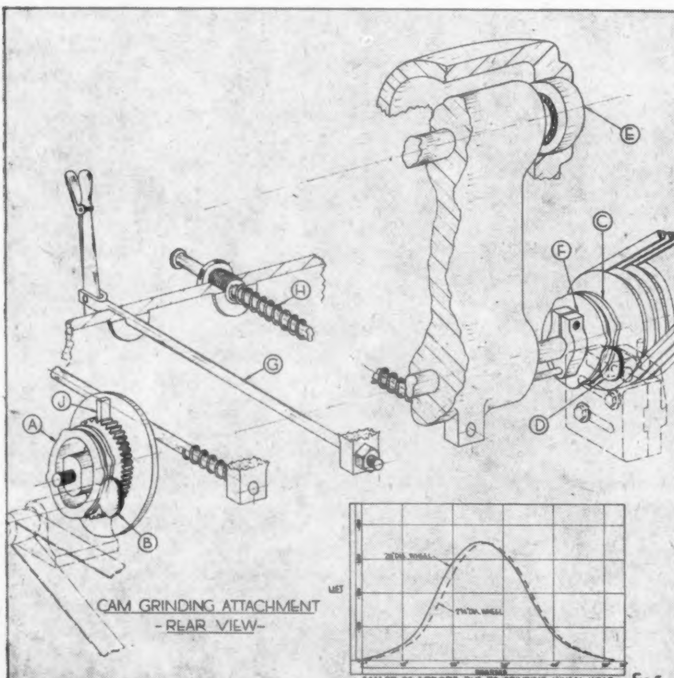

Fig. 5.

Between the spindle flange and the boring bar is a device called an "Inertia Head."

This incorporates an eccentric and a couple of stops, and its purpose is to clear the tool away from the hole after finish boring, in order not to mar the finished surface when withdrawing the tool.

The inertia due to stopping and starting the spindles gives the necessary movement on the eccentric from one stop to another.

Cam Grinding.

Fig. 5 diagrammatically illustrates the method of grinding the inlet and exhaust cam tracks on an aero engine cam at A.

These tracks are profile milled prior to grinding, and in both operations a timing location is obtained from the gear teeth by locator J.

The grinding wheel is shown at B.

The spindle, which carries the cam at one end, and the master cam at the other, turns in a casting which rocks or pivots about the bearings at E.

This rocking movement is obtained by the lobes on the master cam bearing against a fixed roller, D.

The return movement is effected by springs H. When changing both wheel and roller from one track to another, the lever operating the yoke G acts against the springs until the change-over is effected, after which the spring pressure is released.

The drive to the spindle is by means of Multi-Vee belts, and a brake at F eliminates any chatter due to the drive.

The cam revolves at 7 r.p.m. (or 17 ft. per min.) during rough grinding, and at 2 r.p.m. (5 ft. per. min.) during finish grinding.

An interesting point in connection with cam grinding when using the periphery of the wheel, is that as soon as the diameter of the wheel is reduced due to wear off by diamond dressing, the form ground on the cam is also altered.

The graph shows the difference in figures obtained using a $2^3/_4$ in. diameter wheel (dotted line), and a $2^1/_8$ in. diameter wheel (plain line).

The ordinates of the graph represent the lift in inches of the lobe of the cam, whilst the abscissae indicate the cam degrees.

The plotted curves represent actual figures obtained using the two wheels just mentioned.

The maximum error in lift came to approximately .030 in., which also represents a considerable angular error.

One method of overcoming this problem is to vary the roller diameter by substituting different sized rollers as the grinding wheel is dressed down.

Fig. 6 does not actually refer to radial engine work, it has been included in order to illustrate how the cam grinding errors occur.

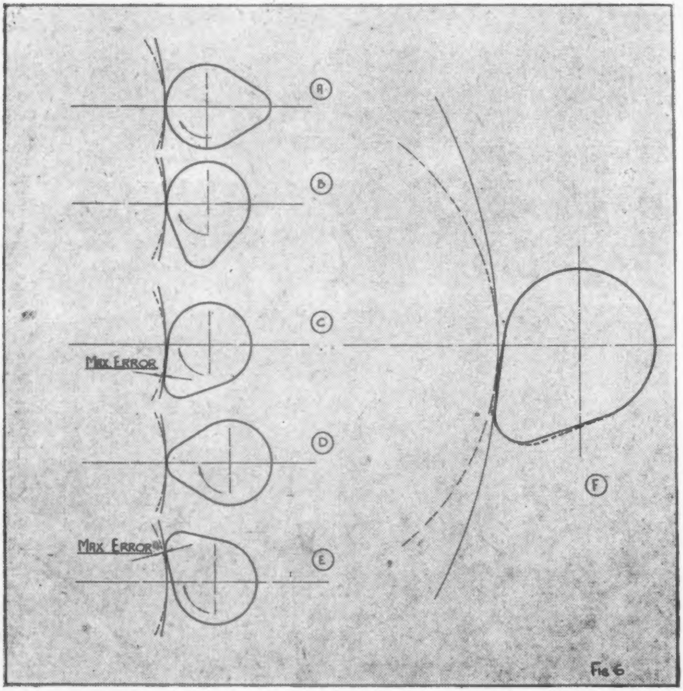

Fig. 6.

On the left of the figure are shown five positions during the grinding of an in-line engine camshaft.

In all cases, the new grinding wheel is represented by a plain line, whilst the dressed down, smaller wheel is represented by a dotted line.

At A the heel or concentric portion is being ground. Note that grinding takes place on the centre line. No error takes place here.

At B still on concentric portion and still on centre line. No error takes place here.

At C the toe is being ground, at the furthest point *below* the centre line. This is the point of maximum error.

At D the extreme point of the toe is being ground. Grinding takes place on the centre line, and no error occurs.

At E the toe is being ground, at the furthest point *above* the centre line. This is again the point of maximum error.

An enlarged view of the error is shown at F.

Drilling Crankshaft.

Figure 7 is an illustration of an indexing drilling jig, which drills 26 holes, reaming 18 of them, in various positions around the crankshaft.

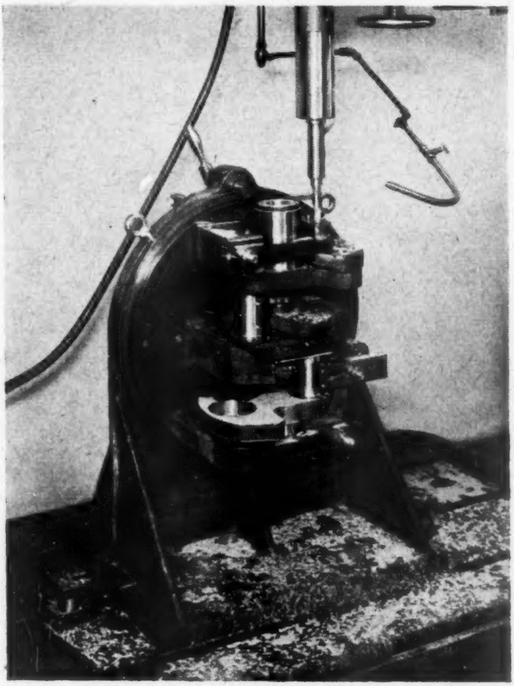

Fig. 7.

The crankshaft is to be seen clamped in the jig, and is located by its two main bearings and one crankpin.

The front portion of the jig which carries the crankshaft is rotated to seven different indexing positions. A hardened and ground plunger slides in a bush in the main casting and slips into bushes at

the back of the revolving portion. At the top will be seen the clamp holding the revolving casting back against the main casting, thus acting against the thrust of the drills.

Arbors.

Fig. 8 illustrates several types of arbors used.

At A is shown what may be termed a "rocking washer." This washer has semi-circular ridges on opposite sides, at 90° from each other. The special feature of this washer is that it is self aligning if either the arbor nut or component is not square, thereby preventing the arbor from bending when the nut is tightened.

An example of this is to be seen at B and C, both arbors being designed to hold nine $^{5}/_{16}$ thick gear blanks, 5 in. outside diameter, $\frac{5}{8}$ in. bore.

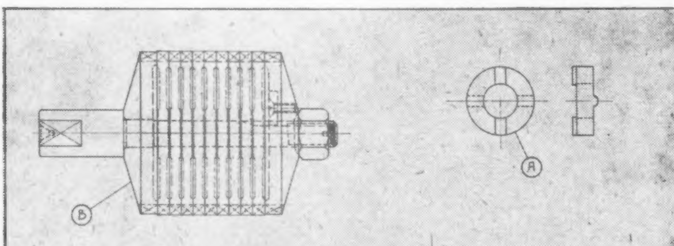

Fig. 8.

The operation is to hob the teeth prior to hardening and gear grinding.

The gear blanks are rarely parallel from the surface grinding operation, and using the design of arbor shown at B, the moment even a light pressure was exerted on the spanner, the arbor immediately " bowed " or " sprung " from .004 to .006.

The improved design, incorporating two rocking washers, is shown at C. An 18 in. spanner failed to spring this arbor more than .003 in.

At D is shown a tappet guide mounted on a grinding arbor incorporating a similar type of rocking washer at the nut end, and a different type at the opposite end.

The washer at this end has to accommodate itself to an angle of approximately 10°. This angle on the component varies slightly, and it is obvious that with a fixed thrust face, the arbor would inevitably spring.

E illustrates an arbor for holding threaded parts. In order to remove the component, the nut is loosened enabling the thrust face to move away, thus facilitating the unscrewing of the component.

F illustrates an expanding type of arbor. This is used for grinding exhaust valve seats.

At G is to be seen an arbor holding a bevel pinion blank.

In order to gauge the diameters of the angles, a removable flush pin gauge is used, which locates in a bush pressed into the body of the arbor.

Gear Manufacture and Checking.

Fig. 9 shows two fixtures holding bevel gears.

At D is a grinding fixture for finish grinding both the bore and thrust face of a small bevel gear.

The finished teeth locate upon a number of accurately ground steel cones.

The clamping arrangement for this fixture is interesting. In order to reduce the size of the base, the clamping stud is designed to move back with the clamp when the clamp is withdrawn to clear the gear.

This reduces the size of the clamp, and consequently the fixture.

A shows a turning fixture used to finish turn a large bevel gear. A feature of this fixture is the " built-in " gauging equipment, C showing the application of plate gauges for checking both angles, and at B a special design of " flush-pin " gauge for checking the diameter of the angles.

For the application of this gauge, a hardened and ground bush is provided in the base.

The other view is an end elevation of this gauge.

In operation, the gauge is inserted in the bush, and turned in

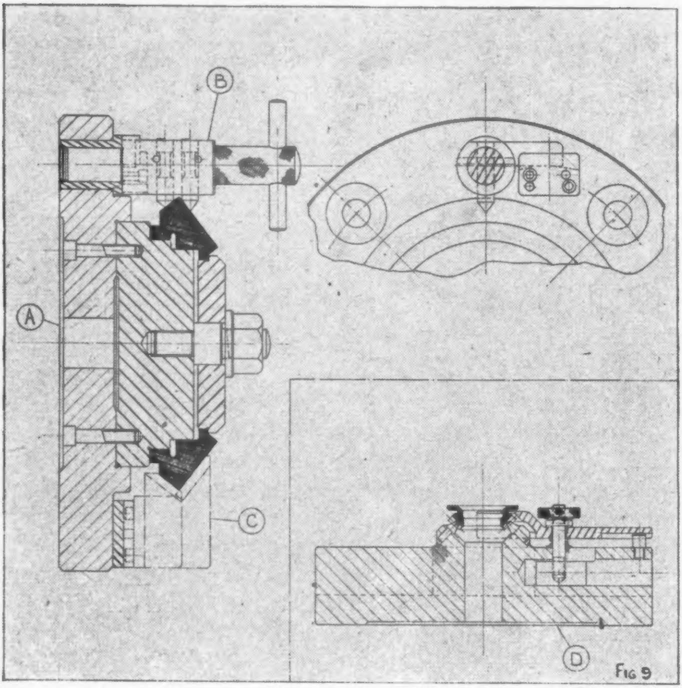

Fig. 9.

a clockwise direction until the projecting arm bears against a locating plate, thus centralising the flush pins.

Fig. 10 illustrates how the same bevel gear is quenched, using specially designed quenching dies in a quenching machine.

During the designing of these dies, modifications may be required in the sizes of the gear immediately prior to quenching.

Certain dimensions may be required to be held to closer tolerances.

At B the gear before quenching is shown, together with the sizes and tolerances which affect the location in the dies.

The quenching machine is operated by compressed air, and at A are the expanders, which are segments of a circle, and which are forced outwards by controlled pressure by means of a cone.

Due to the shrinking of the gear during quenching, the expanders

are forced inwards until stopped by a central plug. Their outside diameter now equals the bore of the gear prior to quenching.

The top plate of the die incorporates two rings, which keep the gear flat during the quench.

In order to overcome inequalities in the gear, these two rings bear against a number of rocking pins.

C is a sectional view of a pitch line locating fixture, also for the same bevel gear.

This fixture is used for the final grinding of the bores and the thrust face, all in one operation.

The gear is located in the finished teeth by means of three parallel rollers, which in turn bear in a hardened and ground steel cone.

These finger clamps, located directly above the rollers, clamp the gear down without tilting, due to a three pronged spider,

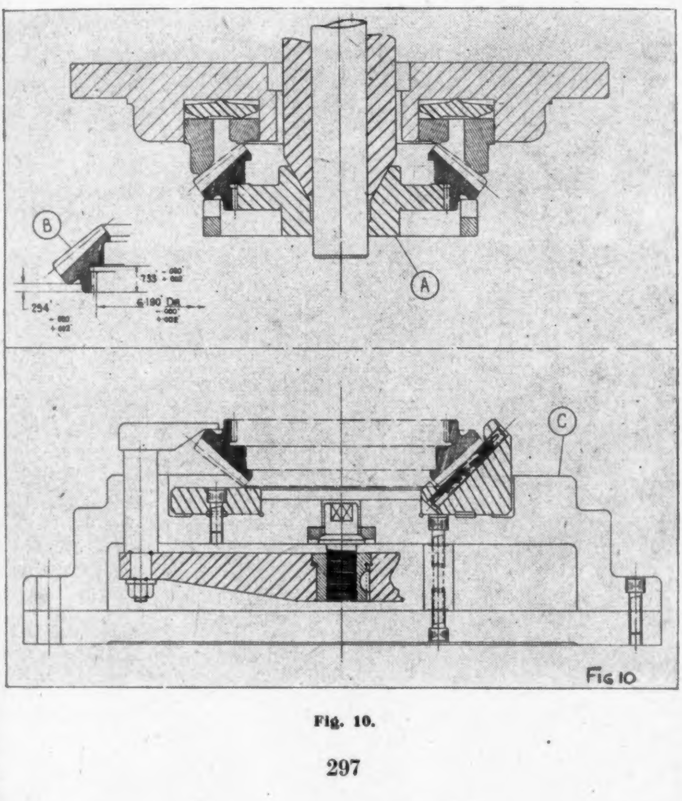

Fig. 10.

operated by one clamping screw, thus centralising the pressure.

Gears are ground on a machine using the generating principle. The machine is similar in action to a shaping machine, and the ram, which is hydraulically operated, carries a grinding wheel, which is dressed on each side to the pressure angle of the gear being ground, the wheel then representing the basic rack tooth.

The gears to be mounted between centres on a table, and rolled very slowly past the wheel by means of a master rack and gear, the grinding wheel passing rapidly to and fro across the face of the gear.

The master gear is of exactly the same pitch diameter as the gear being ground, and is fastened directly on to the tapered end of the work spindle.

Although the number of teeth in the master gear must be the same as the gear being ground, it is not necessary to have the same pressure angle for the teeth.

As the table reaches the end of its travel, with the work out of engagement with the grinding wheel, the rack lifts up, the master gear is indexed one tooth, and the rack again brought into mesh.

The gear, during indexing, revolves a number of times, and for the best results, the wheel is dressed prior to the finishing grinding revolution.

This generating process is superior to the form grinding method, principally owing to the difficulty of accurately dressing the wheel for the latter process.

Gear Checking.

Fig. 11 shows various methods used to check the important dimensions of involute spur gears.

At A is a base circle of a gear, with a number of involute curves run off from it.

In the production of accurate gears, it is necessary to accurately measure these curves, particularly if *form* grinding of the teeth is employed.

The sketch at the left is a diagrammatic illustration of an involute checking machine, in which the gear to be checked is mounted between centres, virtually rolled upon its base circle, and its involute profile checked by means of an indicator.

However, instead of having to make up a base circle diameter disc for every size of gear, only one disc is used, this being 20 in. diameter, or actually a segment of this diameter of exactly 10 in. radius.

In order to compensate for the difference between this 10 in. radius roller and the base circle radius of the gear being checked, a 10 in. sine bar is used to give a pre-determined, constant rate of lift to the indicator.

Part No	No Teeth	D/P	P/A	Pitch Dia	Normal Pitch	Chord Thick	Size Over Teeth		Size over Rolls		Vinco Sine Bar Setting Block	Vinco Indicator Setting Block	Vinco Degrees Inv Roller	Odontometer Setting Block
					A		E		F		X	B.C.R.		B
32160	28	5·6/7	20°	5"	·5272	·278 ·274	1·9129 1·9081	4	5·4364 5·4348	·3120	2·2870	2·3492	29½°	·3852
13128	7	6	28°	1·6667	·4623	·258 ·256	·7965 ·7956	2	1·7225 1·7184	·3510	·5144	·5151	60½°	·5203

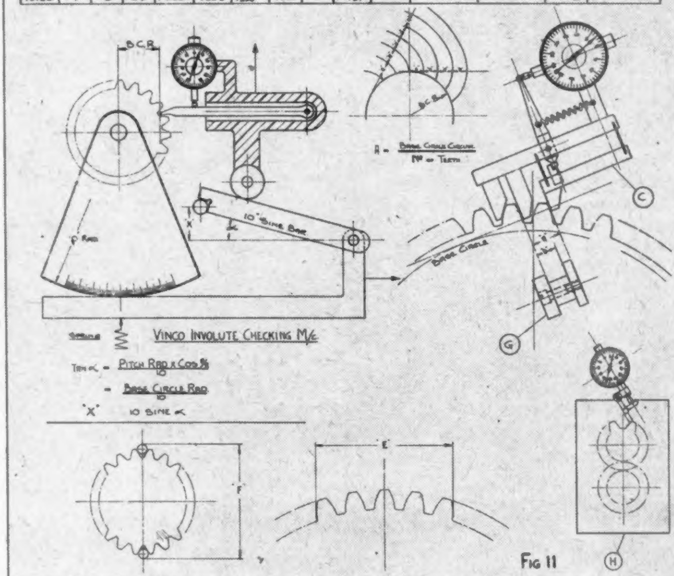

Fig. 11.

The setting for the sine bar is obtained as follows :—

$$\text{Tan } \alpha = \frac{\text{Pitch Radius} \times \text{Cos Pressure Angle}}{10}$$

or in other words, $\dfrac{\text{Base Circle Radius}}{10}$

The setting block X = 10 Sin α.

The point of the finger operating the indicator is set to the base circle radius.

Any movement of the indicator needle, either side of zero indicates either a plus or a minus error (see Fig. 12).

At the right is a diagrammatic view of an Odontometer. This is used for checking the uniformity of the spacing teeth, and also for measuring the exact spacing of the involute curves around the base

circle. This latter dimension is shown as the distance A. It is obtained by dividing the base circle circumference by the number of teeth, and is termed the normal pitch.

The Odontometer is merely a device having two parallel jaws, one of which at C can move laterally by means of two thin flat springs, thus transmitting a movement to a lever, and thence to a .0001 indicator.

The parallel jaws are set, and the indicator zero'd, when the setting block G is applied,

The Odontometer is then applied to the gear and gently rocked to and fro to obtain the reading.

A data sheet, portion of which is shown at the top of the figure, gives complete inspection information for every gear on the engine.

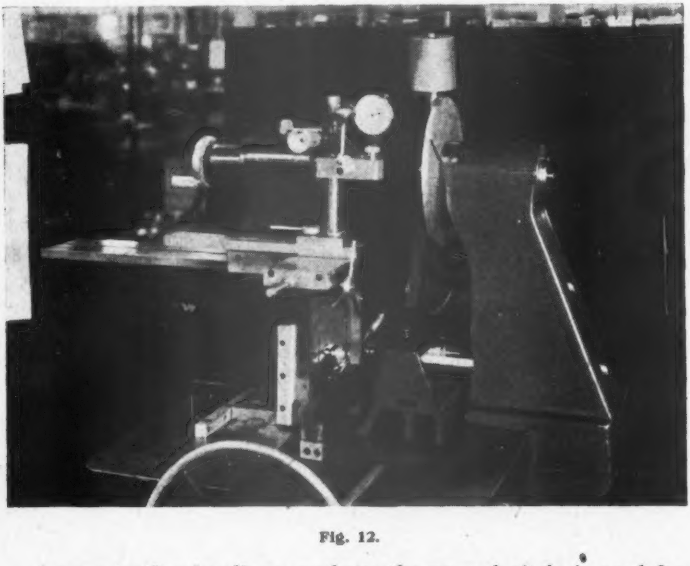

Fig. 12.

Amongst other headings, we have the normal pitch A, used for Odontometer settings ; the size over a specified number of teeth E, see also lower portion of slide ; F giving the size over two known diameter rollers, see also lower portion of figure ; the setting block X for setting the sine bar of the involute checking machine ; the base circle radius, which is used for setting the indicator point of the involute checking machine, and finally the degree of involute rolled, for use on the involute checking machine.

At H the backlash method of checking spur gears is shown diagrammatically.

All gears, whether spur or bevel, are finally checked by the backlash method, both as a check on the other methods, and for obtaining tooth markings.

The larger bevel reduction gears, however, do not have separate backlash fixtures, as these are checked on a special Gleason testing machine.

The next example deals with :—

Cutting Tools.

These play a very important part in all of the manufacturing operations, and their design and manufacture are closely tied up with the variety of materials required to be machined.

For instance, the standard type of face milling cutter is not suitable for milling aluminium and magnesium alloys. For these materials, very sharp cutting edges with very small lands are essential, as well as having a very large chip clearance, much more than even a roughing cutter used for steel.

Cemented carbide tipped tools, whether for turning or milling are more suitable than high speed steel for aluminium and magnesium alloys—particularly where the aluminium alloy contains high percentage of silicon.

Prior to the advent of cemented carbide tips suitable for high tensile alloy steels, butt welded high speed tools were largely used for turning, but these are being supplanted by tantalum and titanium carbide tipped tools, these having a higher transverse rupture strength than plain tungsten carbide, which however, is still extensively used for machining non-ferrous metals.

Tipped tools can be operated at from *twice* to *four times* the speed of high speed tools, depending upon the machinability of the material and some excellent finishes can be obtained and maintained.

The class of finish is effected, amongst other things, by the quality of the tool sharpening and most tools are sharpened by the toolroom, who work to up-to-date blueprints of each tool.

The tool design office keep these prints up to date, and make alterations where necessary from time to time.

This is one place where the data, collected by the use of the Profilometer, can be put to use by recording on the operation sheets the feeds and speeds found to give the desired finish. This applies particularly to cylindrical grinding operations.

Component tolerance effects both the design and manufacture of the tools, these being designed either solid or adjustable as required.

The toolroom should endeavour—where necessary—to make a

good job of the tool, such as grinding and lapping the flutes of reamers, also lapping the peripheral lands of some reamers.

Following are a few examples of titanium carbide tipped tool performance.

Facing Cheeks of Crankshaft. Which at this stage is at approximately 45 tons tensile.

The cut is intermittent, the shaft revolves at 125 r.p.m.—approximately 350 ft. per min.—using a .007 in. feed and $^{3}/_{32}$ depth of cut.

This operation now takes approximately half the time taken using high speed tools.

The Master Rod of approximately 76 tons tensile, is bored on each side of the forging with a boring bar having four inserted tipped tools. The operation consists of boring a 1 in. radius of approximately one third of a circle, in other words an intermittent cut.

A feed of .007 in. was used for both the high speed and the tipped tools.

Using high speed tools at 60 r.p.m.—time taken 10 min.

Using tipped tools at 262 t.p.m.—time taken 2 min., with an incomparably better finish.

Exhaust Valve Seats in austematic stainless steel approximately 3 in. diameter, have been turned using a .005 feed for both high speed and tipped tools.

Using High Speed Steel Tools — 134 r.p.m.
Using Tipped Tools — 239 r.p.m.

Aluminium Bronze Bushes, approximately 1 in. diameter are turned at .004 in. feed 320 r.p.m. using high speed steel and .0075 feed 554 r.p.m. using tipped tools, or at nearly twice the speed and feed.

Shown in Fig. 13 are various types and designs of cutting tools

At A is a large counterbore, the high speed steel cutting portion held to the body of the tool by a pin, and driven by means of a key.

A feature of this tool is the adjustable stop collar for controlling the depth of the cutting.

Two lock nuts are used, with a washer B between them having a flat in the bore, which corresponds to a flat on the threaded portion of the body.

This flat prevents the washer from revolving with the lock nuts, and thereby prevents the lock nuts from revolving in pairs, as lock nuts sometimes will, thus giving an incorrect depth setting.

Referring to C, this is a reamer bar comprising the back piloting portion, the front pilot, and gripped between these are two disc reamers, one roughing and the other finishing.

These reamers are driven by friction only, and have a cylindrical

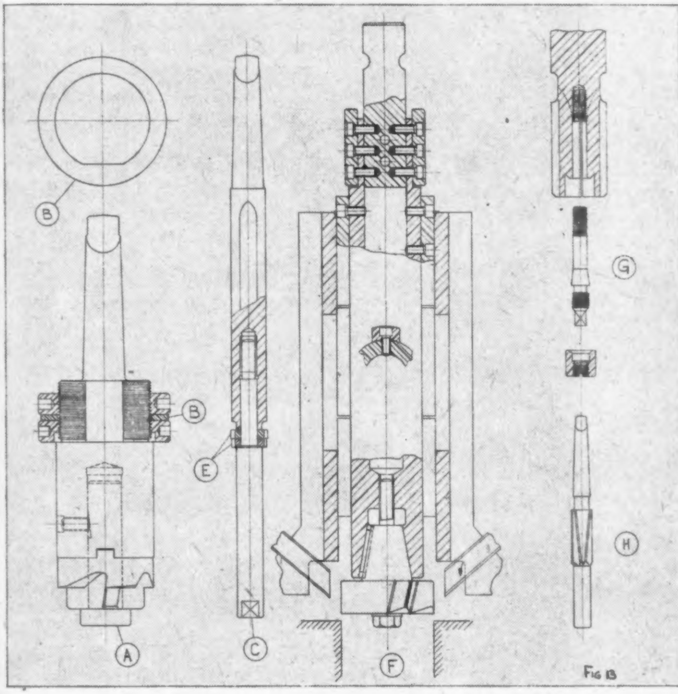

Fig. 13.

land of approximately $^1/_{64}$ in. width, the teeth are straight and have no cutting clearance.

A very accurate hole is produced, and re-sharpening is reduced to simple surface grinding.

In this particular design of reamer body, however, parallelism of the disc reamers is important, otherwise when tightened the whole reamer assembly will spring out og true.

F is an example of a back piloted core drill. Features of interest in this particular example are as follows : The method of locating and driving the core drill insert by means of a steep taper and key, and locking into the body by a set screw, This virtually makes the insert a solid portion of the body, giving great rigidity for heavy cutting.

Pipes carrying the cutting oil right on to both tool and work. These pipes are built in to the drilling jig. The long back pilot, made up of hardened and ground wearing strips, screwed on to the body.

The shank design, enabling a chuck to be used which may be disengaged without stopping the machine, and finally the keys which transmit the drive

In this and the preceeding examples, it will be noticed that a considerable amount of attention is devoted to the saving of high speed steel.

Also of importance is the fact that to obtain efficient production sufficient quantities of cutting tools must always be available in order to eliminate delays due to breakage and to tool sharpening.

It is both cheaper and quicker to manufacture large quantities of inserts rather than complete solid tools.

At G is an expanding reamer, in which the centre screw expands the flutes, whilst the nut limits the amount of expansion.

H shows a solid reamer, employing both RH and LH spiral flutes alternately. This design sometimes gives a better finish.

Broaching Large Splines in Hub.

This is accomplished by use of a hydraulic horizontal broaching machine of 30 tons capacity. The broach component, is a hub of 75 ton alloy steel, with 16 internal straight sided splines of $3^{13}/_{16}$ outside diameter.

The solid high speed steel broach, which is approximately 5 ft. long is supported at the outer end by a cradle, which slides along hardened and ground ways. A spring operated plunger grips the grooved end of the broach with sufficient force to enable the cradle to be pulled along by the broach, and then when nearing the component, strikes a stop and leaves the broach to continue the remaining short distance without support. The effort required to pull the broach through varies from 18 to 20 tons, and the cutting speed of the broach is 5 ft. per min.

Fig. 14 shows further details of this broaching example.

At A are the details of the component, $3^{13}/_{16}$ O.D. Splines, $2^{13}/_{16}$ long, 16 splines, with .001 tolerance on width.

B reveals details of the solid high speed steel broach, with the width of the teeth .002 in. less than the maximum component tolerance.

The teeth of the broach are of $^{9}/_{16}$ pitch, with 15° rake and 3° clearance.

These teeth increase .003 in. on diameter. It will be noticed

that the root diameter of the broach is ground to a diameter corresponding to the root diameter or bore of the component before broaching.

This positively locates the component and prevents any drifting of the broach.

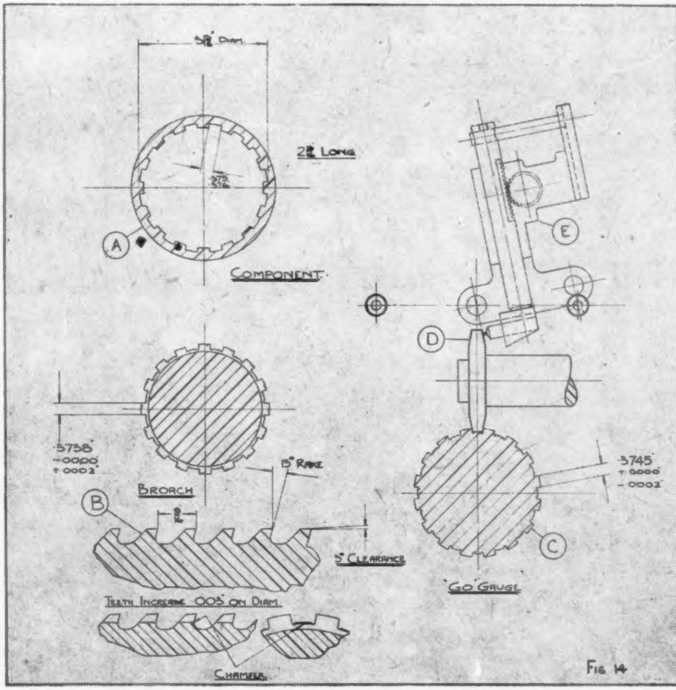

Fig. 14.

In order to prevent this portion of the broach from cutting, a $^1/_{32}$ chamfer is ground as shown.

C shows the full form GO gauge, and the width of these splines is .0005 in. less than the minimum size called for on component.

This allows of a slight spacing error, which is acceptable at assembly.

The diagram illustrates how the gauge is finally ground by wheel

D, which in turn is dressed to the pre-determined angle by the dressing attachment E.

The arm holding the diamond, pivots about a centre and this movement is limited by two hardened and ground buttons, which act as stops.

The diameter of these buttons controls the angle to which the wheel may be dressed.

Movement to the diamond is given by a rack and pinion, and the alignment of the diamond is controlled by a ground pin sliding in a ground groove.

An accurate indexing device for the work completes the equipment required for manufacturing this gauge.

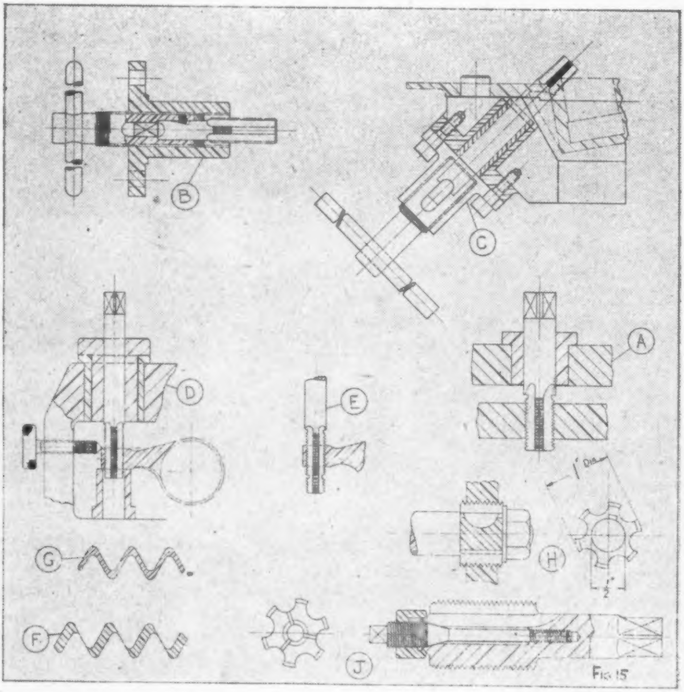

Fig. 15.

Tapping.

A number of special tapping set ups and designs are shown in Fig. 15.

The tap at A has a shank which is larger in diameter than the outside or major diameter of the threaded flutes. This shank is ground to a close tolerance and used as a back pilot to keep the tap square with the work. A suitable tapping fixture employing a hardened and ground bush to suit the tap is also used.

The major diameter of the threaded flutes is not used for piloting as this diameter often varies up to .005 in.

If trouble at assembly is to be avoided, it is essential to tap holes square to mating faces, particularly in cases where long studs are employed.

The tap at B is fastened into a " lead screw," the thread of which is ground and which fits neatly into a screwed slip bush.

This complete unit is used at the drilling operation, and locates in a bush in the drilling jig.

Another example of this is to be seen at C, this time showing a tapered tap. At this operation, the hole is drilled, taper reamed, and then taper tapped.

In magnesium and aluminium alloy castings, it is very easy for a careless operator, without the aid of a lead screw tapping device, to scrap what may otherwise be a finished component.

This is particularly so when taper tapping, as often a hole is merely bored through instead of a thread being produced.

At D and E are roughing and finishing taps respectively for tapping the adjusting screw holes in the valve rocker. This has to be an accurate thread, and must also be perfectly square with the top face of the rocker, upon which a lock nut bears.

A special tapping fixture is used, with slip bushes and back piloted roughing and finishing taps.

The roughing tap which is minus .010, is followed by a finishing tap employing an unrelieved threaded pilot, which is .002 in. less on pitch diameter than the thread produced by the roughing tap.

This method ensures that the finishing tap will clean up both flanks of the roughed out thread as shown at G, instead of possibly only one flank as at F.

A hand spot facing tool (not shown) is next inserted in the tapping fixture, and the top face of the rocker lightly cleaned up, thus ensuring perfect squareness with the tapped hole.

H illustrates the design of a shell tap, which is useful when the saving of high speed steel has to be considered.

J is an expanding or adjustable tap, and is very useful, for sizing close tolerance work.

The centre screw expands the flutes, whilst a lock nut controls the expansion.

The next example is :—

Honing Master and Link Rods.

Master link rods are honed in a fixture holding both a master rod and a link rod.

This set up is for the purpose of honing the bores into which the piston pin bushes are afterwards pressed.

These holes are ground to .0005 in. tolerance before honing, and approximately .00075 in. is removed at the honing operation, which is also held to .0005 in. tolerance.

The hone stones, which are 37 500 J. Norton, revolve at 240 r.p.m. and at 180 reciprocations per minute.

A copious supply of 11 parts Kerosene and 1 part cutting oil is applied through the top portion of the fixture.

Gauging.

Commencing first of all with thread gauges, all screw threads for the engine are in accordance with the Handbook of the Bureau of Standards, Washington.

This handbook gives complete details of the coarse, fine and extra fine pitch series, in four classes of fits and tolerances, and based upon the length of engagement of the mating parts. Sizes and tolerances for screw gauges are also given in complete detail.

For external thread gauging, roll thread snap gauges are used. These gauges have pairs of GO and NO GO rollers, with annular grooves corresponding to the angle of thread and spaced at twice the pitch.

These rolls are fastened to the frames by means of eccentric pins, thereby permitting adjustment for size, using GO and NO GO thread setting plugs.

American standards have been adopted for plain plug gauges, these being tapered inserts up to approximately 1$\frac{3}{4}$ in. diameter, after which Tri-lock inserts are used.

Over 3 in., flat plate plug gauges are used.

For gauging plain external parts, either adjustable built, up or solid plate snap gauges are used, depending upon the application.

In the machining of aluminium crankcases and magnesium rear sections, temperature can have quite an effect when turning these large diameters within the allowable tolerance of .002 in.

The co-efficient of expansion of magnesium alloy, for instance is more than twice that of steel.

In order to overcome this difference of expansion, it was decided to make the body of the 16 in. snap gauge of a magnesium alloy casting, and to attach steel ends.

When completed, the body of the gauge was insulated by means of thin three-ply wood.

The gauge is manufactured as follows :—

The casting is first machined to only a fractional length, recessing the bottom edge $^{1}/_{32}$ in. deep, leaving two pads at either end.

These two pads are then scraped flat, and then each end of the gauge is scraped square and parallel, the two previously scraped pads

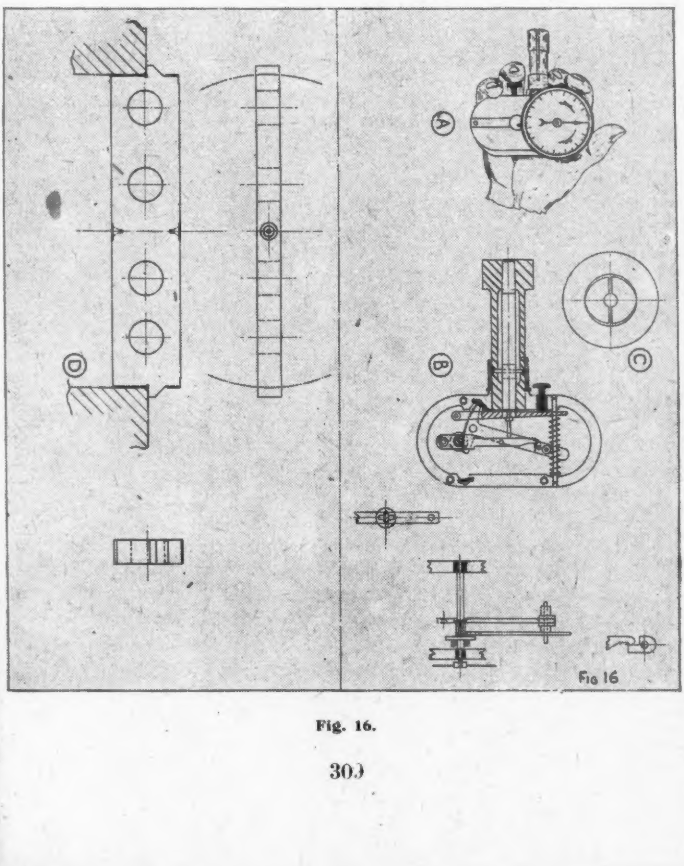

Fig. 16.

resting on a surface plate, whilst the ends are blued by a perfectly square block or cylinder.

Parallelism in the other direction can be checked by direct measurement.

This scraping process is continued, irrespective of sizing, until squareness and parallelism are obtained.

The two steel ends are next completed, the one being plain, whilst the one at the opposite end has the .002 in. step representing the working tolerance.

The grinding and lapping of this step is facilitated by the design of this end piece, allowing a clear run through of the grinding wheel in any necessary direction.

For final sizing, a spacer is made, and is ground and lapped until the desired length between the assembled jaws is obtained.

The design of two rather unusual types of plug gauges are illustrated in Fig. 16.

At A is to be seen an expanding type of plug gauge, which, after insertion into a hole, is allowed to expand by means of spring pressure, and the reading noted upon the .0001 dial indicator, reading plus or minus either side of zero.

This gauge is of course set to a pre-determined size beforehand by means of an accurate ring gauge as shown at C.

The detailed contruction is shown at B. A tapered plunger, operated by spring pressure which is controlled by a compressor button expands the split gauging plug.

An amplifying mechanism transmits the axial movement of the tapered plunger through to the indicator.

Referring back to C, this shows an end view of the gauging portion of the expanding plug, inserted into the ring setting gauge.

In order to avoid false readings, the sides of the split plug are cleared away, and only two portions opposite to the split are used for gauging.

A feature of the amplifying mechanism is that no jewels are used, and the construction is very simple.

In operation, the setting ring is always at the side of the operator and is frequently used in order to verify the setting of the dial.

In this manner, discrepancies due to various causes, including wearing of working parts, cannot cause false readings.

It will be appreciated of course, that the whole length of the gauging portion of the expanding plug must be enclosed within both the setting ring and the work. Should this protrude, a false reading will be the result.

At D is a large, flat steel plug gauge, which is commonly used for gauging diameters 4 in. and upwards.

A point of interest is the projections which allow the gauge, when inserted, to rest squarely against the face of the hole being gauged, thus facilitating the revolving of the gauge in the work in order to check for out of roundness.

The foregoing examples are indicative of the many problems confronting the planning and production of an engine of this type, when full consideration is given to the many differing types of components, each of which presents its own difficulty.

Research Department: Production Engineering Abstracts

(Edited by the Director af Research)

NOTE.—*The addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough.*

COMBUSTION, FURNACE.

Furnace and Dip Brazing of Light Alloys. [*Light Metals, U.S.A., July, 1943, Vol. 6, No. 66, p. 336; Iron Age, May 27, 1943, Vol. 151* (*No. 21*), *p. 52*].

A useful review of American practice in the brazing of Al and Mg. Details of flux compositions are given. In America three alloys of Al, have been standardised and the technique employed is fully described.

(*Communicated by the British Non-Ferrous Metals Research Association*).

Paint and Printing Ink. (*Industrial Gas Times, July, 1943, Vol. VI, No. 70, p. 252; 3 figs.*).

Tricky heat treatment problems solved by gas. Disadvantages of the old method. Oil bodying. The furnace. Another method. Gum running. Costs.

FOUNDRY, MOULDING, PATTERNS.

Centrifugal Casting (of Steel)—A Symposium. (*Iron Age, May 13, 1943, Vol. 151, No. 19, p. 53, May 20, 1943, Vol. 151, No. 20, p. 62*).

" The Development of Centrifugal Casting," by C. W. Briggs; " Centrifugal Casting with Vertical Spindle Machines," by P. C. Power; " Centrifugal Casting in Vertical Machines," by A. T. Baumer; " Centrifuging during Pouring," by A Johnson; " Centrifuging after Filling the Mould," by W. F. Wright and J. B. Caine. Bibliography.

(*Communicated by the British Non-Ferrous Metals Research Association*).

Centrifugal Casting of White Metal. (*Mechanical World, August 20, 1943, Vol. 114, No. 2955, p. 208, 3 figs.*).

A centrifugal casting machine with a movable axis which could at will and whilst running, be set at any required angle to the horizontal. The angle of the spindle may be altered whilst the motor is running, a feature which should prove of great advantage when the molten metal is being poured. Views showing contructional details of machine. The chuck in which the bearing shells are fitted for lining is gas heated.

GEARING.

Precision Forging Pinion Gears, by R. J. Goldie. [*The Tool Engineer,* (*U.S.A.*), *June, 1943, Vol. XII, No. 6, p. 67, 14 figs.*].

Saving critical machinery, material and cost, Timken-Detroit's forging and coining process produces a gear of greater strength. The bar stock weighed 1.65 pounds, whereas the weight of steel for the coined pinion is .92 pounds. On

the larger size, the saving amounts to 2.65 pounds. 200,000 pieces of each kind are used per year. The pinion forging dies. The coining dies. Machining operation sheet : 24 operations. Fixture for holding and centring the pinion in most of the machining operations. Cross-section showing structure of the larger forged pinion.

Only from Accurate Hobs, by J. T. Hess. (*The Machinist, August 7, 1943, Vol. 87, No. 16, p. 83, 5 figs.*).

A hob inspection machine is used to check the diameter of hob teeth, hub faces, and hub-datum diameters. The tooth form is checked for variation in the straight portion, and the symmetry of the teeth, the gash angle and lead of the hob over the cutting edges are determined. The cutting faces of finishing hobs are checked to determine how close they are to being ground radial. The operator checks finishing hobs for radial grind, and roughing hobs for rake angle. Hob sharpening.

Shaving Aircraft Engine Gears, by A. W. Harris. (*Machinery, August 5, 1943, Vol. 63, No. 1608, p. 153, 9 figs.*).

Gears expansion in hardening. Expansion of gear teeth. Development of fillet contours. The active tooth profile. Scraping or burnishing bias. Shaved and ground gears compared. Small gears.

MACHINE ELEMENTS.

Spindle Bearings for Machine Tools, by G. Schlesinger. (*Machinery, August 5, 19, 1943, Vol, 63, Nos. 1608, 1610, pp. 158, 206, 21 figs.*).

Oil wedge. Detrimental effect of misplaced oil grooves. Deformation of spindle during chuck work. Deformation of spindle by work between centres. Corner pressures due to bad alignment of spindle and too much clearance. Ball thrust bearing on rear end. Ball thrust device on front bearing of heavy lathe. Mounting of tool in spindle of milling machine. Cutter head mounted directly on spindle nose of milling machine. Spindle of large drilling machine. Headstock of automatic turret lathe. (Petermann-Moutier). Main spindle nitrided steel $\frac{7}{8}$ in. diameter. 10,000 r.p.m. babbitted bronze bearing. Headstock of diamond lathe (Kaerger) with plain cylindrical front bearing for 3,000 r.p.m. Plain bearing for grinding machine.

Babbitting of Cast Iron Improved by New Process (Using Flo-Metal). (*Product Eng., U.S.A., April, 1943, Vol. 14, No. 4, p. 228*).

The bearing shell is cleaned with Kolene cleaner and dipped in Flo-Metal (described as an alloy of 90% Pb and balance not more than 5% Sn with an Sb content that reduces surface tension). This coating is claimed to give good adhesion to Sn-base and Pb-base babbitts. Other applications, such as coating of pipes, etc., are described.

(*Communicated by the British Non-Ferrous Metals Research Association*).

MACHINING (CHIPS), MACHINE TOOLS.

Burring—Its rapid Evolution from Hand Methods to Mechanical, by R. P. Crane. (*Monthly Rev. Amer. Electroplaters' Soc., April, 1943, Vol. 30, No. 4, p. 343*).

Notes on mechanical burring operations including external, internal and combinations of both.

(*Communicated by the British Non-Ferrous Metals Research Association.*)

Radial Drill Press Operations—XIII, XIV. (*The Machinist, Reference Book Sheet, August 21, 1943, Vol. 87, No. 18, p. 113*).

Time for pipe taps. Time to ream various materials.

Precision Grinding. (*Automobile Engineer, June, 1943, Vol. XXXIII, No. 437, p. 229, 15 figs.*).

Details are given of methods for finishing two faces simultaneously and for using internal automatic grinders for grinding a bore and a face at one setting. Typical examples of the work produced, the tolerances observed and the output rates obtained are also included.

Precision Grinders. (*Automobile Engineer, July, 1943, Vol. XXXIII, No. 438, p. 267, 13 figs.*).

The range of work that can be ground on centreless grinding machines has been greatly extended. The various methods adopted for different classes of work are discussed in deatil. Particular attention is paid to through-feed, infeed, and out-of-balance grinding. Examples are given of actual production data for widely varying jobs. Data in connection with non-metallic bar grinding and for bearing bush grinding are given in tabular form. There is also a table showing faults that may occur in centreless grinding and the methods of correction.

Thread Grinding, by W. A. Atley. (*I.P.E. Journal, August, 1943, Vol.XXII, No. 8, Ed. B, p. 251, 12 figs.*).

Today thread-grinding is recognised as a means by which, in many cases, production of both hardened and soft pieces can be increased. Accuracy of the pitch can be guaranteed, and large numbers of components can be ground without wheel dressing. When designing shouldered work an adequate undercut should be provided at the shoulder. Closer tolerances may be specified if thread-grinding is to be employed. The process of " crushing the wheel." Flat test piece for inspection on projector. Roller of helical form used. Dressing with diamonds. Holder to suit diamond dressing attachment. Matrix Multi-ribbed diamond dressing attachment. Good results from thread-grinding will depend to some extent on the coolant used. A few examples of the type of malformed thread likely to result from a badly crushed wheel.

Heavy-duty Milling Operations on High-tensile Hiduminium. (*Machinery, August 12, 1943, Vol. 63, No. 1609, p. 173, 8 figs.*).

Power consumed by machine for cutters with similar cutting speeds but varying feeds. Cubic inches removed per machine-H.P., consumed by cutter for varying thicknesses of chip at three different cutting speeds. Cutter limitations on hiduminium.

CHIPLESS MACHINING

Two-stage Drawing of Cylindrical Cups (continued), by Professor H. W. Swift. (*Sheet Metal Industries, August, 1943, Vol. 18, No. 196, p. 1365, 11 figs.*).

The influence of inter-stage heat treatment on the redrawing of mild steel. Development of thickness strains during initial draw. Resultant thickening during radial drawing non-hardening material. Second stage drawing tests. Nickel silver. Assembled redrawing characteristics. No inter-stage heat treatment. Second stage drawing tests. Mild steel. Second stage drawing tests of Aluminium bronze, soft Aluminium, half-hard aluminium.

MANUFACTURING METHODS.

The Cheetah X, by J. A. Oates. (*Aircraft Production, September, 1943, Vol. V, No. 59, p. 418, 31 figs.*).

Part II. Machining the cylinder unit, induction casing rear cover and the crankcase; assembly and testing.

Recommended Dimensions for Aluminium Castings. (*Product Eng., U.S.A., April, 1943, Vol. 14, p. 234*).

Twenty-four drawings showing forms that have proved satisfactory in avoiding unexpected failures and difficulties in production. Methods of joining walls of the same and different thicknesses, dimensions for beading around holes, sleeves and ribs, flange and bolt hole proportions, etc.

(*Communicated by the British Non-Ferrous Metals Research Association*).

MATERIALS, MATERIAL TESTING.

Scarce Materials are Vital to the War Effort, by W. J. Clardy. (*Mechanical Engineering, U.S.A., August, 1943, Vol. 65, No. 8, p. 567*).

Scarce materials : Metals ; steel products ; chemicals ; alloy steels ; plastics ; lumber ; textiles and fibres ; other products. Measures to relieve shortages. Substitutions and reduced used. Scrap recovery. Maintenance and shop practice. Conservation programme will progress.

Substituting Steel for Brass in the Press Shop. (*Sheet Metal Industries, August, 1943, Vol. 18, No. 196, p. 1409*).

Some details of technical difficulties encountered and overcone in the making of steel cartridge cases at the Buick Motors Division of the General Motors Corporation.

Silicon Bronze Castings, by E. Portman. (*Metals and Alloys, March, 1943, Vol. 17, No. 3, p. 528*).

Author describes the experience of a foundry in which Si-bronze is melted in a high frequency induction furnace and sand cast. He recommends omitting charcoal and liquid fluxes, and melting the metal in a hot crucible fitted with a cover ; for good machinability he recommends addition of only 1 oz. phosphor-copper per 180 lb. melt. He discusses the relative merits of the hardeners commonly used, soldering problems and corrosion properties.

(*Communicated by the British Non-Ferrous Metals Research Association.*)

Free-Machining 36% Nickel Alloy Steel (Invar.), by J. W. Luerssen. (*Aero Digest, U.S.A., March, 1943, p. 229*).

By adding Se to Invar, Carpenter Steel Co., have developed an alloy with good machining properties which retains the low-expansion properties of the original Invar.

(*Communicated by the British Non-Ferrous Metals Research Association.*)

(I) Designing with Magnesium (II) Magnesium properties as they affect design. (*Prod. Eng., U.S.A., May, June, 1943, Vol. 14, Nos. 5, 6, pp. 276, 325*).

The first two of a series of articles digested from a forthcoming book. First part deals with the advantages of Mg alloys as structural materials, methods of fabrication and tensile properties (mechanical and physical proper-

ties and American specifications are given). Part II deals with elasticity, compression strength, bending strength, hardness, wear resistance, resilience, toughness and fatigue (recommendations for design and machining practice, and methods of attaching wearing surfaces of other materials are given).

(*Communicated by the British Non-Ferrous Metals Research Association*).

Improving Fatigue Strength of Machine Parts, by J. O. Almen. (*Mechanical Engineering, U.S.A., August, 1943, Vol. 65, No. 8, p. 553, 26 figs.*).

New concepts of fatigue phenomena by which new avenues of reasoning are opened to us are : (1) Fatigue failures result only from tension stresses, never from compressive stresses. (2) Any surface, no matter how smoothly finished, is a stress raiser. Fatigue vulnerability. Fatigue life increased. Comparison of normally finished railway axles with axles undergoing rolling operation. Benefits of surface-peening based on fatigue life. Explanation of peening effectiveness. Stress patterns. Stress diagram for a loaded prestressed beam. Residual thermal stresses. First use of surface compression. Prestressing may be overdone. Apparatus for measuring compression-stressed layer. Measuring strips. Instrument measures peening. Stress imposed by various surface treatments. Failure from severe tension stress resulting from deep nitriding. Overdose of nitriding. Residual stress from honing. Residual stress resulting from carburising and hardening. Residual stress from carburising. Low temperature quenching stresses. Variation in internal stresses from different quenching methods. Fatigue life increased. Corrosion promotes fatigue. Surface finishes. Surface fractures resulting from grinding. Residual stress caused by grinding. Measurements of hardened layer. Machining damage. (a) Machined ; (b) Lapped ; (c) Shotblasted. Materials are elastic. Gear contact impressions. Localised gear-tooth load. Gear failure. Compromise treatments. Physical tests. Fatigue tests on machine parts. Fatigue data are mortality data. Variation in durability.

Effect of Screw Threads on Fatigue, by S. M. Arnold. (*Mechanical Engineering, U.S.A., July, 1943, Vol. 65, No. 7, p. 497, 6 figs.*).

A review of the literature. Amplification of published data required. Effect of grooves and threads on endurance strength. Results of rotating-beam endurance tests on medium carbon steel. Concentration of stress. Method of manufacture. Summary of rotating-beam endurance tests on low-carbon-steel screws. Choice of material. Influence of composition of surface layer. Effect of surface coating and anodizing. Effect of thread contour. Stress-concentration factors for various screw threads. Results of rotating-cantilever-beam tests on various thread types. Effect of surface-rolling. Effect of length of free threads under nut. Effect of body diameter of bolt and bolt steel on repeated-impact fatigue stength of bolts. Influence of temperature on endurance strength. Effect of root radius of thread on repeated-impact fatigue limit of bolts. Fatigue strength of various threaded joints. Improving fatigue strength of threaded materials. Influence of the nut. Bibliography.

Practical Method of Segregating Steel Swarf. (*Production and Engineering Bulletin, August, 1943, Vol. 2, No. 9, p. 397, 10 figs.*).

The organisation. Identifying the material. The marking on the machine. Clearing the machines. Crushing the swarf. Reclaiming the oil from swarf.

MEASURING METHODS, APPARATUS.

Quantitative Determination of Retained Austenite by X-Rays, by F. S. Gardner, M. Cohen and D. P. Antia. (*Amer. Inst. Mining and Metallurgical Engineers, Tech. Publn. 1560, 11 p, Metals Technology, February, 1943*).

Symposium on Radiography as an Inspection Tool. (*Met. Progress, U.S.A., February, 1943, Vol. 43, No. 2, p. 226*).

Short accounts of papers. " X-Ray Inspection on a Production Scale," by T. A. Triplett ; "Acceptance Standards for Light Alloy Castings," by W. H. Burroughs ; " Limitations of Radiography as an Inspection Method," by V. I. E. Weigand ; " New Developments in Equipment, Films and Technique," by L. W. Ball.

(*Communicated by the British Non-Ferrous Metals Research Association.*)

PLASTIC MATERIAL.

Symposium on Powder Metallurgy. (*A.S.T.M. Bull., March, 1943, No. 121, p. 7*).

Papers read were " Powders for Powder Metallurgy," by C. Hardy ; " Effect of Pressure on Properties of Compacts," by C. W. Balke ; " Role of Diffusion in Powder Metallurgy," by F. N. Rhines ; " Effect of Particle Size on Shrinkage of Powder Metal Compacts," by P. R. Kalischer ; "Alloy Powders," by T. H. Lasher ; " Metal Powder Friction Materials," by J. F. Kuzmick ; " Hot Pressing," by W. N. Pratt.

(*Communicated by the British Non-Ferrous Metals Research Association*).

The Machining of Laminated Plastics. (*Machinery, August 26, 1943, Vol. 63, No. 1611, p. 225, 3 figs.*).

Appropriate methods for drilling, turning and boring, lapping and grinding and screw cutting these plastics. Cautions for machining. Saw cutting fabric-resin. Characteristics of the fabric-resin and paper-resin laminated plastics are : Mechanical strength, lightness, resiliency, heat and electrical insulation, not susceptible to electrolytic effects—or to corrosion (save by alkalis and strong nitric acid), and not deteriorated by immersion in water

Powdered Metal Facings for Clutches and Brakes—I, II, by M. S. Adler, R. B. Aufmuth and F. L. Lowey. (*The Machinist, August 14, 28, 1943, Vol. 87, Nos. 17, 19, p. 106E, 108E, 2 figs.*).

Part I. The use of powdered metals in friction elements for clutches and brakes has developed into one of the most important applications of this class of materials and products. Powdered metal friction elements for clutches and brakes. Riveted-on facings. A typical composition contains 73 Cu, 14 Pb, 7 Sn, and 6 graphite. Various facings and sandwich-type discs.

Part II. " Wet " clutches and brakes. Rivet arrangement.

POWER, DRIVE.

Clean Motors Seldom Fail, by C. A. Atwell. (*Machine Shop Magazine, August, 1943, Vol. 4, No. 8, p. 43*).

Cleanliness is a most important factor in the maintenance of electric motors. What is dirt ? How dirt affects motors. Oils retain dirt. How to keep motors clean. Lubrication of bearings. Cleaning of bearings.

SHOP MANAGEMENT.

Fundamentals of Personnel Management, by H. W. Locke. (*Institute of Labour Management, Booklet, Price 1/-*).

Work and character. What is work ? Work should be satisfying. The work-group a social factor. The firm an organic whole. Importance of social work-relations. The work-group the basis of wider co-operation. The democratic

method the key to good industrial relations. Voluntary co-operation the basis of modern industry. Consultation essential to real co-operation. Men respond to humane treatment. Persuasion better than force. The aim of personnel management.

Introducing the New Employee to the Job. (*Personnel, U.S.A., July, 1943, Vol. 20, No. 1, p. 15*).

With workforces expanding to an unprecedented extent, there is an unfortunate tendency among many companies to speed up the induction process and rely on hit-or-miss methods of introducing the new employees to their job. Such companies fail to realize that the future worth of employees is largely determined by the type of adjusment which they make during this impressionable period. The article, adapted from material prepared by Training Within Industry, outlines a model systematized induction programme and indicates the modified procedures to be followed in inducting rehired or transferred employees.

The Management Review. (*U.S.A., July, 1943, Vol. XXXII, No. 7.*).

The following reviews are of interest for the Production Engineer :—
The Selection of Wartime Supervisors, p. 245.
The Simpler Things to Come, p. 252.
Outline for Postwar Planning. p. 261.
Current Inventory Problems, p. 266.

The Importance of Personal Contact, by H. A. Goddard. (*Industrial Welfare, July—August, 1943, Vol. XXV, No. 289, p. 108*).

The Nuffield organisation. Initial reception. Introduction to the factory. The welfare council. Individual problems.

Wages, by C. H. Northcott. (*Institute of Labour Management, Booklet. Price 1/-*).

1. Wages as a personnel problem. 2. Wage principles. Guaranteed minimum, 3. Forms of wage payment. (A) Time rates. Graded rates. (B) Piece rates. Advantages of the system. Disadvantages. Time study. (C) Incentive bonus schemes. (D) Production bonus.

Quality Control Charts. (*Production and Engineering Bulletin, August, 1943, Vol. 2, No. 9, p. 385, 9 figs.*).

Explaining the chart and its interpretation. The production characteristic. Control. Sample means. Drawing requirements. The range chart. Degrees of assurance.

Quality Control will Reduce Costs, by J. Manuele. (*The Machinist, August 21, 1943, Vol. 87, No. 18, p. 78, 4 figs.*).

Rejections can be held to a minimum by inspecting the parts during early production stages. Errors in dimensions can then be averaged and tool set-ups or designs changed accordingly. Example: a moulded part with important cavity: Table I, Deviation in parts before cavity correction. Table II. Deviation in parts after cavity correction. Table III. Defect record before using quality control. Patrol inspection controls accuracy. Table IV. Effects of using quality control.

Shop Loading, by D. Tiranti. (*Mechanical World, August 20, 1943, Vol. 114, No. 2955, p. 199, 2 figs.*).

How it applies to factories of different sizes, and methods for practical week-to-week control. Function of production planning. Purpose of shop loading.

Basic principle. Shop loading statistics. Shop balance. Rate-fixed times. Different methods. (a) small factory, (b) large factory. Advance shop load. Batch load. Current shop load. Shop loading the machine shop presents certain features and certain arguments. Loading and off-loading. Toolroom loading provides contrast to the machine shop-loading because it is, in effect, work on individual pieces as distinct from production runs. Presentation of information.

SMALL TOOLS.

Nitriding High-speed Tools, by G. Walter Esau. (*The Tool Engineer, U.S.A., June, 1943, Vol. XII, No. 6, p. 87*).

Carbides produce soft skin. Secret of uniformity. Depth of hard case :

1050°F.	Penetration	Average Case-Brinell
30 min.	.0013	937
60 min.	.0017	1026
90 min.	.0019	1065

Plastic Punches are Tough (Pressworking Aluminium Alloys). (*Machinist, U.S.A., June 5, 1943, Vol. 87 (No. 7), p. 9*).

Advantages and production of plastic punches for pressworking Al. alloys for aircraft parts.

(*Communicated by the British Non-Ferrous Metals Research Association*).

Wood Pack Reamer Finishes Contour, by Gerald E. Stedman. (*Tool Engineer, U.S.A., July, 1943, Vol. XII, No. 7, p. 69, 6 figs.*).

Components of the 90 mm. gun. Body and parts of powder chamber reamer with copper coolant tube. Wood pack being turned to size. Purpose of the wood pack. Fitting the woods. Wood pack is oversize.

Surface Protection of Magnesium, by S. H. Barmasel. (*Iron Age, U.S.A., April 22, 1943, Vol. 151, No. 16, p. 44*).

Describes methods in use for the prevention of corrosion in climates of high humidity and temperature. Degreasing, chemical treatments, painting and varnishing.

(*Communicated by the British Non-Ferrous Metals Research Association*).

SURFACE, SURFACE TREATMENT.

Chrome-Plating Gauges. Precision Plating—How to do it, by L. W. Macomber. (*The Tool Engineer, U.S.A., June, 1943, Vol. XII, No. 6, p. 89, 4 figs.*).

Reclaiming precision blocks. Reclaiming cylindrical gauges. Plating procedure. Eight factors are involved in plating uniformly : (1) Proper work suspension. (2) Design and arrangements of anodes. (3) Accurate placement of anodes. (4) Proper design of thieves. (5) Proper cleaning procedure. (6) Proper temperature of solution. (7) Accurate current density. (8) Accurate time control.

The Joining and Protection of Metals, by D. G. P. Paterson. (*Sheet Metal Industries, August, 1943, Vol. 18, No. 196, p. 1349, 8 figs.*).

Atmospheric corrosion. Rusting of iron and steel. Electro-chemical aspects. The electro-chemical series. Rust prevention : galvanising. Hot-dip galvanis-

ing (hand dipping a fabricated tank). Tinplate. Electro-deposition. Anodising. Sherardising and calorising. Cladding. Spraying. Other protective methods.

TECHNICAL EDUCATION.

Training Foremen in Human Relations, by Robert A. Sutermeister. (*Personnel, U.S.A., July, 1943, Vol. 20, No. 1, p. 6*).

Foremen untrained or improperly trained in the psychology of supervision represent one of the most significant causes of dissatisfaction and poor morale among employees today. Indeed, in many expanding war plants the unfamiliarity of " green " foremen with the cardinal principles of leadership has been responsible for a serious slowdown of production. In the paper Mr. Sutermeister restates the fundamental maxims of supervision which are overlooked or ignored by many inexperienced foremen.

Improving Job Efficiency through Supplementary Training, by R. B. Cribbs. (*Personnel, U.S.A., July, 1943, Vol. 20, No. 1, p. 49*).

Off-the-job classes frequently offer the best means of providing intensive instruction at the specific points where it is most needed. In this article the author shows how such subjects as blueprint reading and shop mathematics may be broken down into their various componenets to insure that the men in each department learn exactly what they need to know and waste no time on elements which will be of little value to them in their work. He also outlines a comprehensive supplementary training programme, describes how it may be utilised to build morale, and suggests a method of evaluating the results.

TECHNICAL INFORMATION.

Design for the Future of Industrial Relations, by C. L. Huston, Jr. (*Personnel, U.S.A., July, 1943, Vol. 20, No. 1, p. 24*).

What major labour trends now under way are shaping the future pattern of industrial relations? Will management or labour hold the reins in the postwar years? In the paper a number of specific forecasts on the postwar character of industrial relations are offered. The author maintains that, in the last analysis, the pattern of industrial relations will be determined by the attitudes and actions of employers and by how well they fulfil their responsibilities.

Development Trends in Spot Welding and Spot Welding Equipment, by J. L. Miller. (*Welding, August, 1943, Vol. XI, No. 9, p. 364, 3 figs.*).

Measurement of current and time. Projection welding. Multiple welders. Single phase, 3 phase and storage welders. Control systems.

The Organisation of the Employment Office, by A. K. Rice. (*Industrial Welfare, July-August, 1943, Vol. XXV, No. 289, p. 104*).

The job to be done. The tools are the records kept—both individual and group records. Using the tools. A standard requisition form. The complete picture of the job and the person required to fill it. Starting work. Maintaining the records. Group records.

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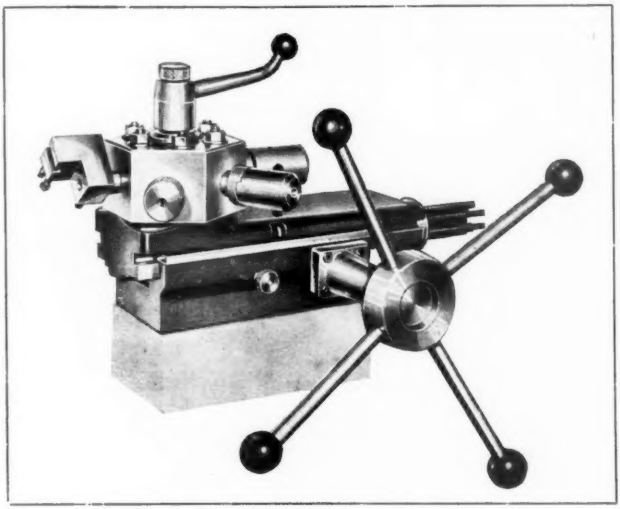

HEIGHT OF CENTRES AS SUPPLIED 4½ in.
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Suitable for use with ATLAS, SOUTHBEND, SPHERE and other types of lathe of about 4½ in. to 5 in. height of centres.

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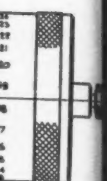

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